MACHINERY.

January, 1904.

THE NEW HAMILTON-CORLISS ENGINE WORKS.

THE shops of the Hooven, Owens & Rentschler Co., Hamilton, O., builders of the Hamilton-Corliss engines, have been rebuilt and greatly enlarged the past two years, and the new machine equipment is now practically completed. The scheme of arrangement of buildings, power plant, tracks, machines, etc., is that of Colonel J. C. Hooven, president of the company, and the details were worked out by the architect, Mr. George Barkman, of Hamilton. The buildings are most substantially constructed of steel frames with brick walls. The roofs are high and the lighting exceptionally good. The machine-tool equipment is in many instances of a special character, and is designed for handling both horizontal and vertical

Fig. 1. Heavy Machinery Bay of new Hooven, Owens & Rentschler Engine Works, looking South, served by two Four-motor Fifty-ton Cranes of 73 feet 6 inches Span. Length of Bay, 370 feet.

Corliss engines up to the heaviest units, say 5,000 or 6,000 horse power. The large tools are independently driven by electric motors, and electrical distribution of power is used throughout. In fact the plant is up-to-date, and is perhaps one of the best equipped plants in this country for building heavy Corliss steam engines.

The layout of the plant is seen in the plan, Figs. 5 and 6. The machine, erecting and blacksmith shops lie on the south side of Heaton street, and the foundry, pattern shop, pattern storage and power plant are on the north side. A large tunnel beneath the street connects the machine shop and power plant. In this tunnel the electric cables, steam pipes, water pipes and other connections are laid. The motive power in the power house consists of a 500 kilowatt Hamilton-Corliss cross-compound condensing engine, exhausting into a Baragwanath barometric condenser, and direct-connected to a "Wood system" generator built at Fort Wayne, Ind. For lighting a 150-kilowatt generator, belted to an 18 x 36-inch engine, is provided. For view of engine room see Fig. 18. The engine house is a handsome two-story building of pressed brick, and may be seen at the right in Fig. 19.

The tracks of the Panhandle Route (P. C. C. & St. L. branch of the Pennsylvania Railroad) are immediately adjacent to the shop buildings on the east, and the Cincinnati, Hamilton & Dayton Railroad runs along the west boundary. A switch from the latter curves through the side of the erecting shop, passes through the machine shop and back of the blacksmith shop, where it intersects that from the Panhandle Route. An industrial railway connects the machine shop with the foundry, foundry yard, etc., but transportation within the shops is mainly effected by the electric traveling cranes, with which the plant is exceptionally well equipped, there being eight in machine shop and erecting shops alone. The foundry has two, each of thirty tons capacity, besides which there is one of thirty tons capacity in the flask yard. For handling heavy patterns in the pattern shop a small traveling crane is provided there.

The length of the foundry is 406 feet, and the width of the main part, in even figures, is 74 feet. A lean-to is built on the west side, as is the usual practice, for the cupolas and core ovens. The lean-to is continued, however, from the cupola room to the end of the structure, a distance of about 233 feet.

The width of the foundry with the lean-to is 113 feet. The foundry floors are composed of clay and molding sand, except in the charging and cupola rooms, where the floor is made of one-inch steel plates laid upon steel I-beams. The roof over the cupolas is fireproof, being built of steel rafters with porous book tile between and covered with sea-green slate laid in a bed of hot asphalt. This roof is especially recommended for cupola rooms, not only because of its fireproof qualities, but because the fumes and gases do not deteriorate it. Three cupolas of 67, 81 and 90 inches diameter, give ample melting capacity for the largest castings. Three wheel casting pits are provided in the north end of the molding floor. The wall of each pit is a cast-iron ring about 5 feet high, 3 inches thick and 23 feet internal diameter. As already stated, the foundry has two electric traveling cranes of thirty tons capacity each. The span is 69 feet 9 inches. A cross section of the foundry and lean-to appears in Fig. 9. The crane in the foundry yard for handling flasks is a lattice girder crane of thirty tons capacity, and is of the same length of span as those in the foundry. A view of this crane and the flask yard appears in Fig. 26, and view of the foundry lean-to, looking towards the machine shop, in Fig. 20.

The machine shop extends along Heaton street 316 feet. The rebuilt part of the machine shop was part of the old foundry. This portion runs parallel with Heaton street and consists of two bays, each provided with traveling cranes. Views of these bays are shown in Figs. 4 and 24. The main erecting and machinery bays, four in number, 370 feet long and 230 feet wide, are at right angles to the street, as may be seen from an inspection of the plan, Fig. 6. A cross section of these bays is shown in Fig. 8, and half-tone views in Figs. 1, 2, 3, 21 and 22. The rectangular space included in the angle made by the east bay (running north and south) and the south bay (running east and west) is used as a fitting department for such engine parts as cam hooks, dash-pots, governors, etc. Beyond this department, toward the blacksmith shop is an old five-story building used for light machinery and storage. The screw machine department is on the ground floor, and the appreciation of the Jones & Lamson machines is shown by the fact that seven machines are in use, three of which are 2 x 36 inches capacity.

The most impressive parts of the plant are the high sections indicated in the cross section, Fig. 8, and of which half-tone views appear in Figs. 1, 2 and 3. The steel columns supporting the roof, are very heavy and are spaced 29 feet apart. All the weight of the roof throughout the plant, including the shafting, is supported by the columns, the brickwork acting only as a filling between the outside columns. The height of the roof trusses from the floor is 57 feet, and the tops of the crane runways are 45 feet above the floor. All the foundations are made of concrete, as actual tests had satisfied the company that concrete formed a more stable foundation than stone; besides its use hastened the work and cheapened the cost. The foundations of the floors are also of concrete,

Fig. 2. Erecting Bay, 320 feet long. Has two Iron-concrete Erecting Floors, each 27 feet wide and 102 feet long; one Four-motor Thirty-ton Traveling Crane. Entrance for Railroad Switch shown by "jog" in Wall.

8 inches thick. Upon this 4 x 6-feet cedar sleepers are laid, 2 feet apart center to center. The sleepers are coated on all sides with hot asphalt, and the space between them is filled up to the level of the top with fine concrete. Upon the sleepers the flooring is laid, which consists of 3-inch plank covered with a finished floor of 1¼-inch tongued and grooved edge-grained yellow pine. The sleepers are somewhat wider at the bottom than at the top, so they cannot lift, being dove-tailed, as it were, into the concrete.

The erecting floor space is 102 feet long and in two parallel sections each 27 feet wide. These are built of concrete, in which are embedded cast-iron rails each made with longitudinal T-slots. These rails are 6 inches deep and are made in 6-foot lengths, each of which is held down with six bolts. A bed of concrete 12 inches deep was rammed up to within one inch of the bottoms of the cast-iron rails, which were leveled and held in place by temporary supports. Liquid cement was then floated over the concrete up to the under side

Fig. 3. Heavy Machinery Bay, looking North.

Fig. 4. Machinery Bay parallel to and next to Heaton Street, served by two Twenty-ton Traveling Cranes of 47 feet Span.

of the rails, thus giving them a perfectly even bearing under all parts of their bases, which are about 12 inches wide. The spaces between the rail were then filled in with rammed concrete up to within one inch of the top, and the intervening space was floated level full with liquid cement. The rails are laid about 3 feet apart center to center, and the T-slots may be plainly distinguished in the view of the erecting floor, Fig. 2.

The traveling crane over the erecting floor is of 30 tons capacity. It has four motors, the main hoist being driven by a motor of 30 horse power. The power of the other motors and of those of the two 50-ton cranes in the next bay may be read from the cut, Fig. 6. Save tools of a portable nature, there will be only one machine tool in the erecting section or bay. This is a 40 x 12-foot pit lathe, located at the south end. This machine had not yet been erected at the time the photo-

Fig. 15 handles Corliss cylinders up to 72 inches diameter, and bores the ports simultaneously with the machining of the main bore. The main bar is driven through worm gearing by a 12-horsepower variable-speed motor. The two port boring bars are independently driven by a 7½-horsepower variable-speed motor. Another interesting heavy tool is the bed-facing machine seen in Fig. 16. This machine has two boring bars mounted at right angles. One bar bores the main shaft bearing, while the other bores the guides and faces the end of the frame for the cylinder fit. Large and small bars with bushings fitting the machine so that they may be readily interchanged are provided, so that large and small frames may be handled on the same machine. The shaft bearing boring bar is driven by a 7½-horsepower variable speed motor, and the guide boring and facing bar is driven by a 12-horsepower variable-speed motor.

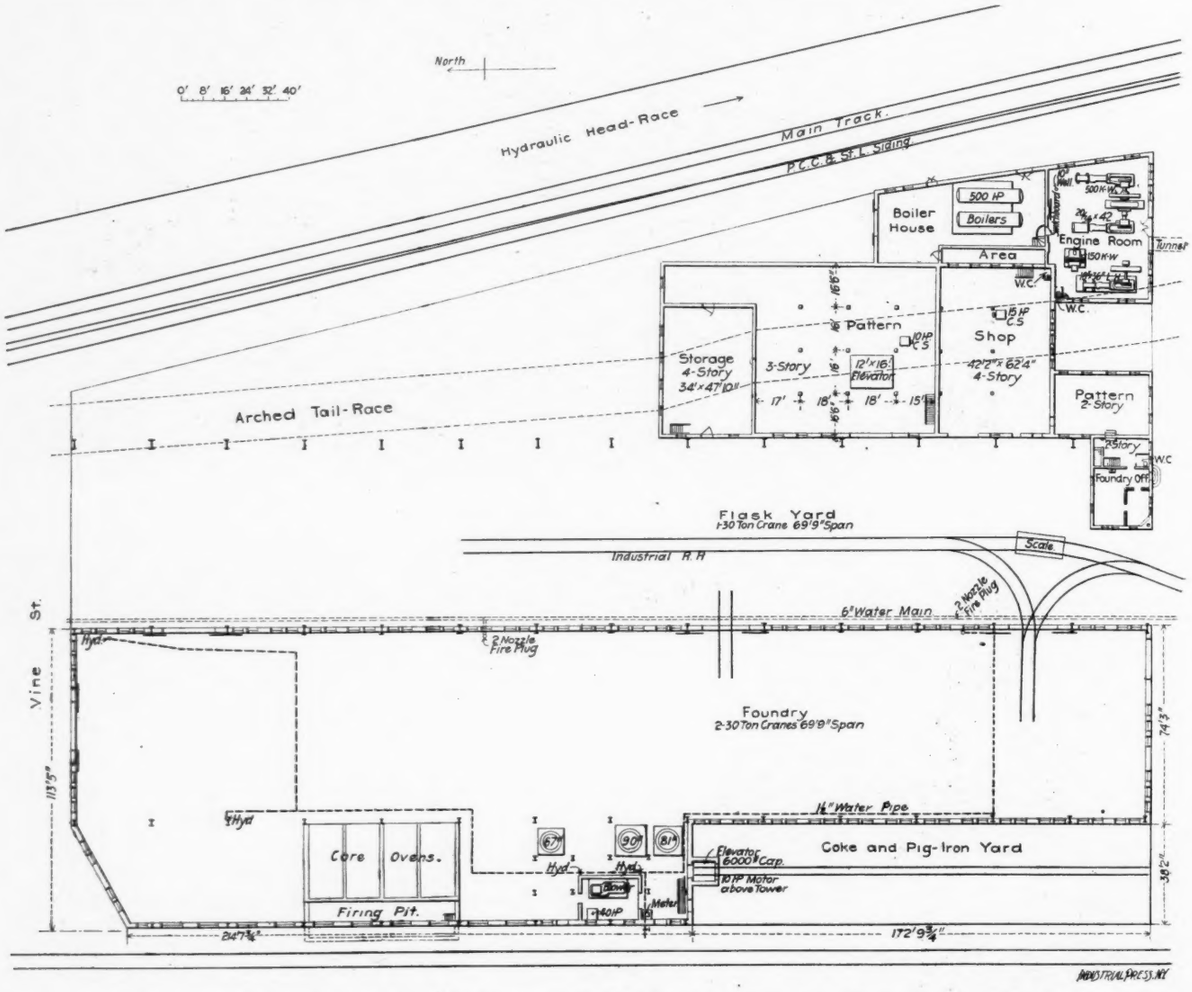


Fig. 5. Plan of Hooven, Owens & Rentschler Works, showing Foundry, Pattern Shop, Power Plant, etc. (See next page.)

graph was taken. It is a home-made tool and is now in process of construction. At the opposite end of the erecting floor is the office, which is four stories high and has a cellar. The stairways leading to the second and third floors are indicated in Fig. 8, and are on the shop side of the partition wall.

The heaviest machine tools are in the next bay, which is served by the two 50-ton cranes. The heavy planer shown individually in Fig. 13 was built by the Niles Tool Works, as were most of the other heavy machines. It is a 12 x 12 x 30-foot machine, with four heads, and is driven by a 40-horsepower constant speed motor. Fig. 14 shows a view of a heavy 20-foot boring and turning mill from the rear. This machine has an auxiliary post or housing, carrying the tools for turning the rims of fly-wheels. It is driven by a 20-horsepower variable-speed motor, and has a 7½ constant-speed motor for rail elevation. The cylinder borer appearing in

The Bullock four-wire multiple voltage system is used for the variable-speed motors. A balancing set consisting of three machines of 17½ kilowatts each, mounted on one base, is located centrally in the shop near the tool room. The power wires are all carried beneath the floor, and connection boxes are placed at frequent intervals. The only overhead wiring is that necessary for the electric lights. Near the balancing set is a 45-horsepower constant-speed motor, belted to the line shaft in that bay. In this section all the tools are belt-driven from the line shaft. A view of it is shown in Fig. 21.

This bay, of course, is not served by traveling cranes, because of the presence of the lineshaft, but primarily because of the low roof, this section being a lean-to, although the next bay is covered with an ordinary ridge roof. In the next bay there are two 20-ton traveling cranes of 34 feet 3½ inches span, and the tools are independently motor-driven. The power of the individual motors is, in most cases, given on

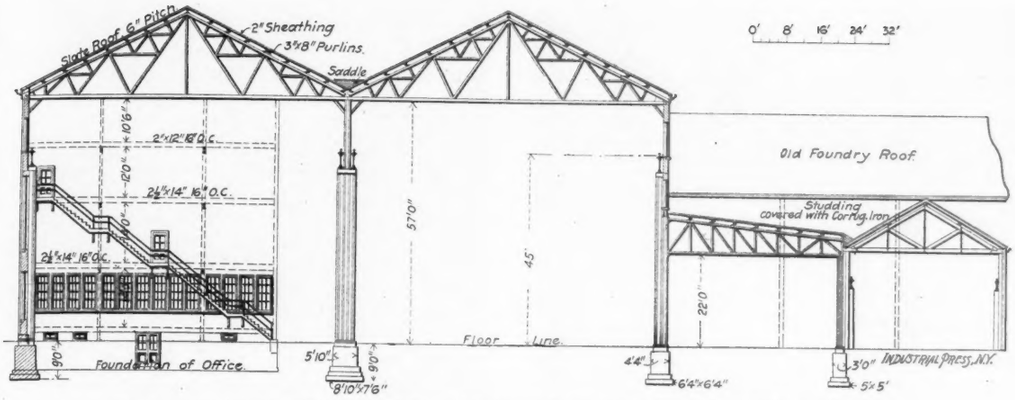


Fig. 8. Cross-section of Erecting and Heavy Machinery Bays; also of Lean-to and Ridge-roof Section.

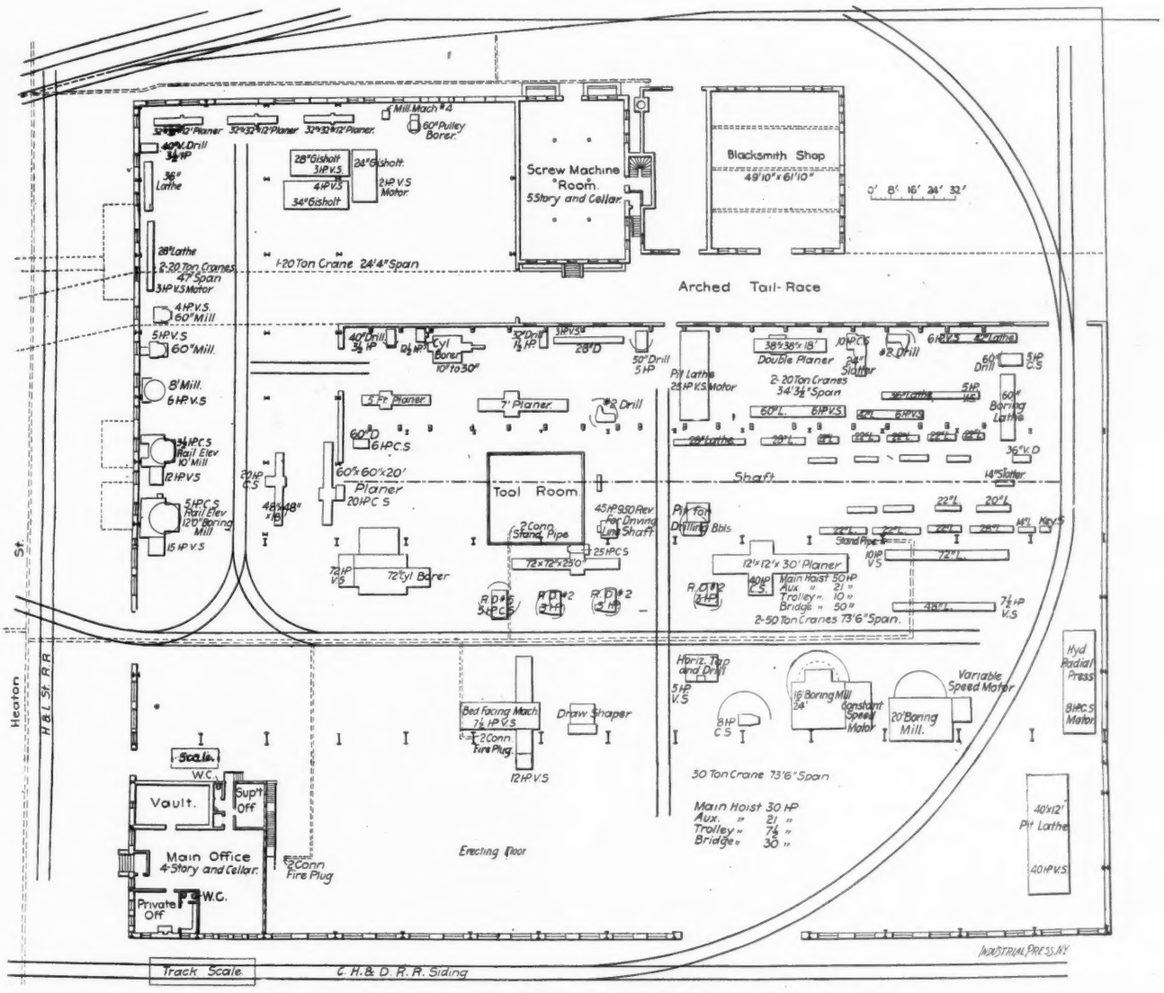


Fig. 6. Plan of Works showing Machine and Erecting Shops and Blacksmith Shop.

the drawing, Fig. 6. One of the interesting tools in this section is the Niles double connecting-rod planer, with which both ends of connecting-rods may be planed simultaneously; it is shown in Fig. 17.

The boring mill seen in Fig. 11 is one of a row of mills located along the Heaton street wall, shown in the general

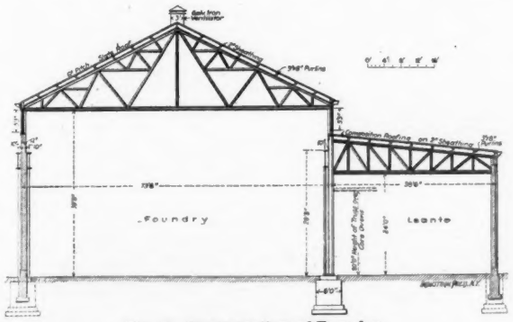


Fig. 9. Cross-section of Foundry.

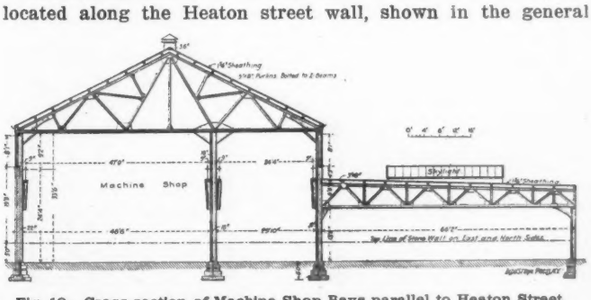


Fig. 10. Cross-section of Machine Shop Bays parallel to Heaton Street also of Fitting Department.

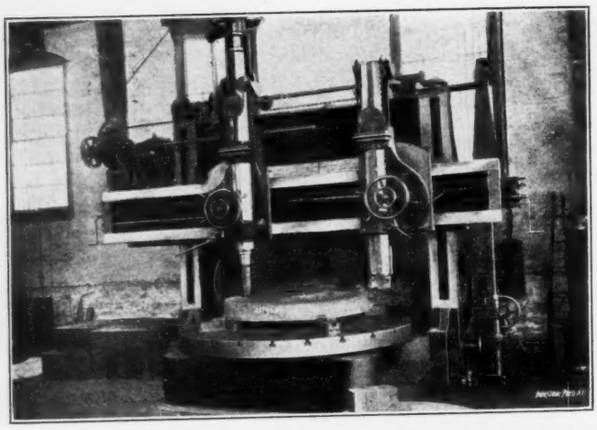


Fig. 11. Ten-foot Boring Mill with Revolving Bar used for Crank Disks.

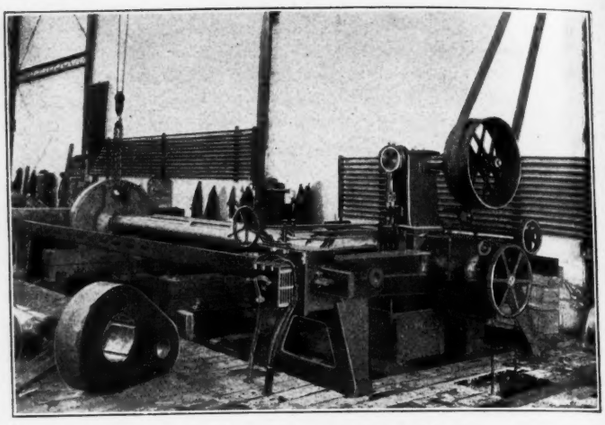


Fig. 12. Hydraulic Press, Electrically Driven.

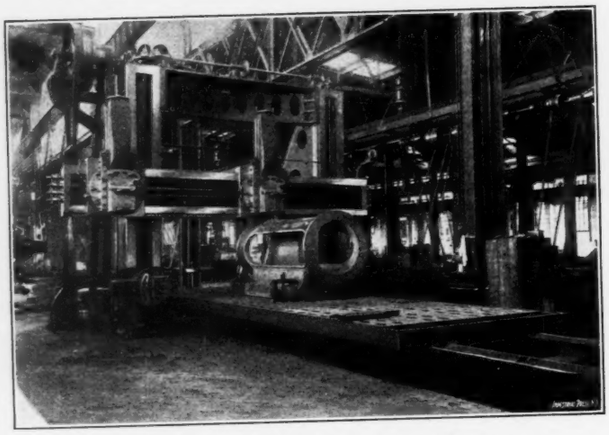


Fig. 13. Heavy 12 ft. x 12 ft. x 30 ft. Niles Planer.

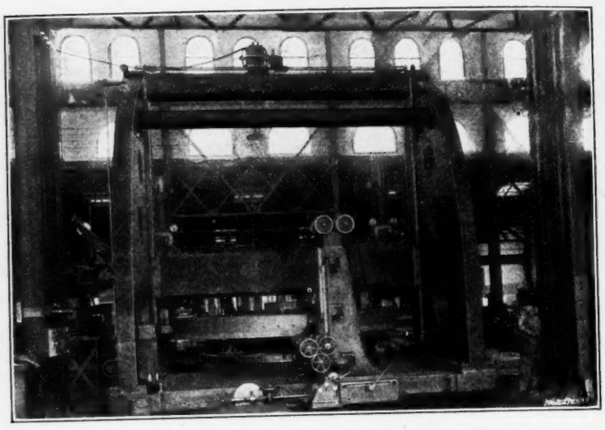


Fig. 14. Heavy 20-foot Boring Mill with Auxiliary Column.

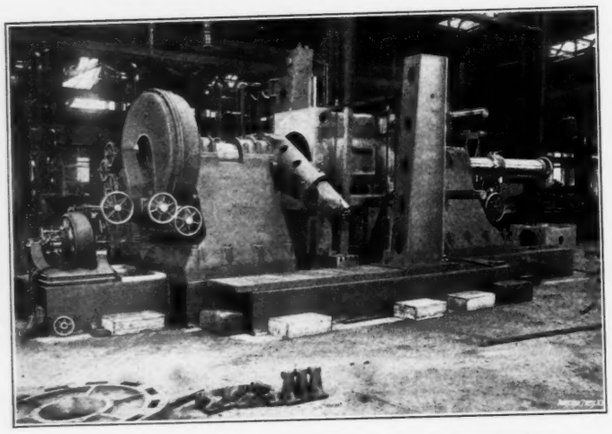


Fig. 15. Worm-driven 72-inch Cylinder and Port Boring Machine.

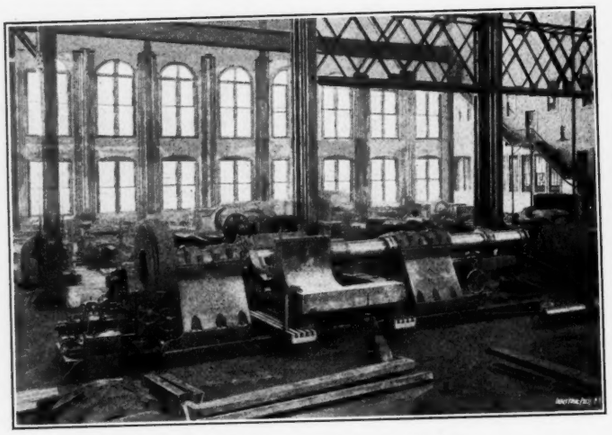


Fig. 16. Bed Boring and Facing Machine.

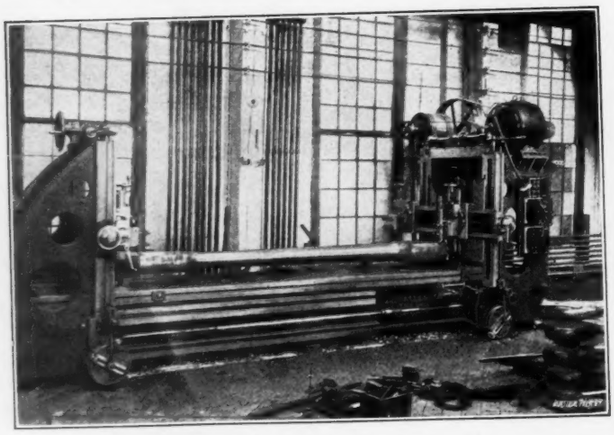


Fig. 17. Double Connecting-rod Planer.

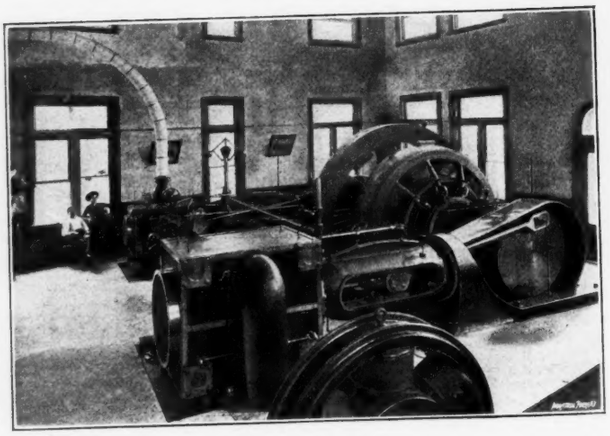


Fig. 18. Engine Room.

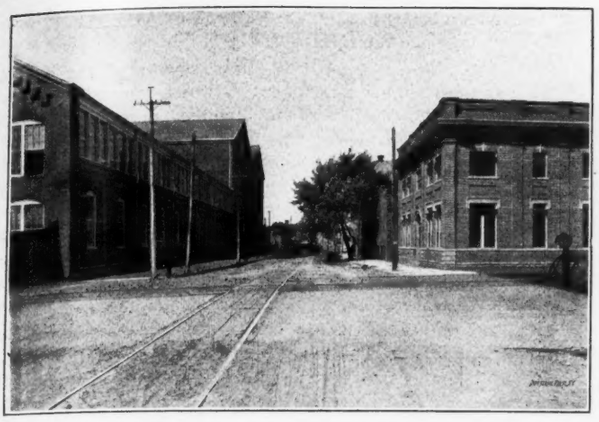


Fig. 19. Heaton Street, showing Machine Shop on the left.

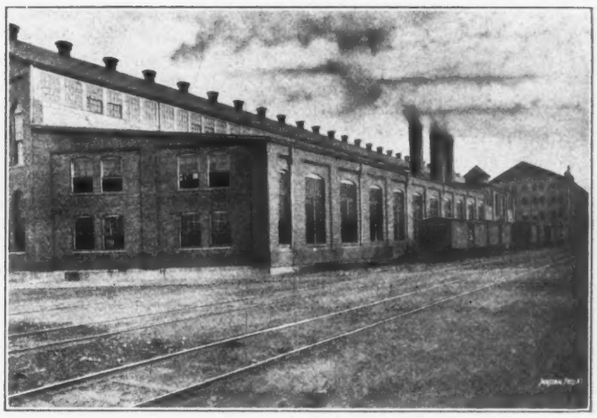


Fig. 20. View of Foundry looking South, towards Machine Shop

Fig. 21. Machinery Bay, with Countershaft.

Fig. 22. Low Ridge Roof Machinery Bay, looking North.

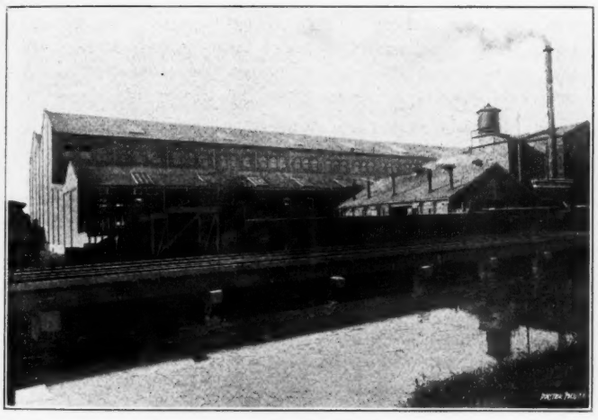


Fig. 23. View of Machine Shop from rear, showing Blacksmith Shop.

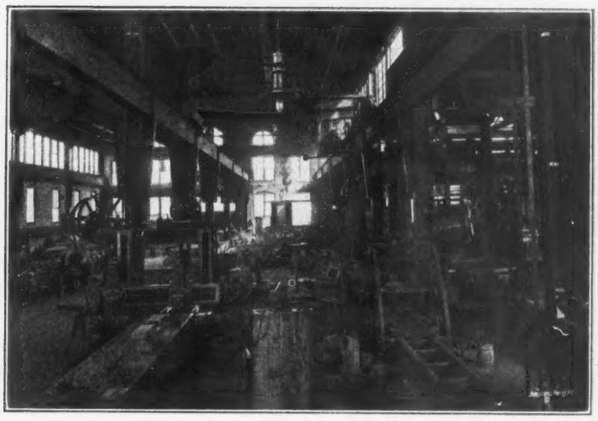


Fig. 24. Narrow Machinery Bay, parallel to Heaton Street, looking East.

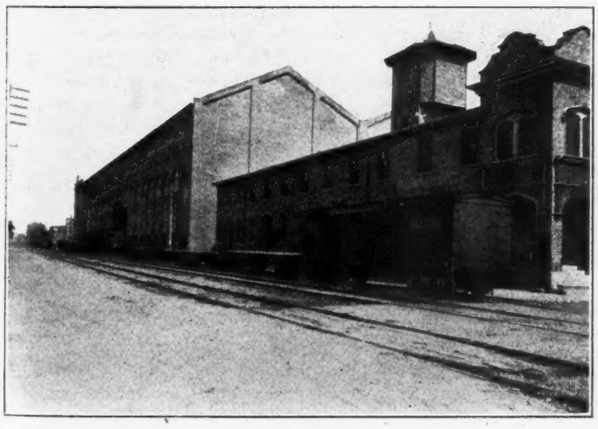


Fig. 25. New Portion of Machine Shop—Erecting Shop Side.

Fig. 26. Flask Yard and Traveling Crane.

view, Fig. 4. This mill swings 10 feet and has a boring bar which is used for boring crank-pins holes in crank disks, the table and disk, of course, standing still during such operations. With this machine the crank-pin and shaft holes can be bored and the disk turned and faced at one setting. This tool, it may be safely said, is about the best example of a combination machine. Ordinarily a combination tool is not much of a success, that is, those in which radically different operations like slotting and boring are conducted on the same machine.

Attention is called to the large hydraulic press seen in Fig. 12, which is used for pressing shafts into crank disks, etc., to observe the convenient manner in which electric controller and valve connections are located, all being brought to one spot, where the operator can watch the pressure gage. The press is belt-driven by a 8-horsepower constant-speed motor.

The cubic space of the various sections of the machine shop just described, which are practically all in one room, measures about 5,000,000 cubic feet, and the area of exposure is proportionally enormous. The original plans of heating proposed by Mr. Thomas G. Smith, of Cincinnati, the consulting engineer, contemplated the use of the hot air plenum system as being best suited to the needs of large open buildings such as these, but this system was finally abandoned for direct radiation from low-pressure steam coils. This action was taken partly because of the difference in cost, but largely because the company did not want the large underground ducts which would have been necessary with the hot-air fan system. Because of the great cubic space and large exposures it was quite a problem to secure the space for the pipe coils giving the necessary amount of radiating surface, and for this reason the installation is somewhat unusual, inasmuch as the most of the coils are placed vertically between the windows. This may be seen in the view, Fig. 2, where it will be observed that the proportion of horizontal piping beneath the windows is small as compared with the vertical pipes between them. Ceiling coils are also placed so as to aid the circulation and contribute to heating the large body of air in the center of the shop.

The Webster system of steam distribution is used. The steam supply from the power plant is carried across the street in the tunnel into the machine shop where the main rises to the level of the roof trusses and extends throughout the bays to supply the coils. The returns are conducted back to the tunnel in trenches near the walls of the building, and through the tunnel to the vacuum pump located in the basement of the main engine room. Branch mains, of course, are run to the pattern shop, pattern storage warehouse, and screw machine department. The exhaust of the main engine, supplemented with live steam through a pressure-reducing valve, is used for heating, so that the engine is practically run non-condensing in winter so far as any contribution from atmospheric pressure is concerned. It is only in summer when this economy can be realized.

The offices are in the northwest corner of the erecting shop, the required space being taken from the north end of the erecting bay. On the first floor are the main and private offices and the superintendent's office. The latter is so located that the interior of the shop may be seen through windows cut through the partition wall for this purpose. These rooms are handsomely finished in mahogany and present a fine appearance. The second floor is used for drawing room, and the third floor is reserved for the same purpose when a large force is being employed. A three-story fireproof vault affords safe storage for valuable papers for each floor.

* * *

A distinctive feature of electric welding is that the interior is raised to the welding temperature before the surface reaches that heat; heating in the forge is the converse of this condition. With electric welding if the exterior surfaces weld the operator is sure that the interior is also welded since it must be at a somewhat higher heat. With forge welding the surfaces may be welded perfectly and cover an imperfect job within. Unfortunately electric welding seems practicable only for comparatively small pieces on account of the enormous amperage required for large sections.

REFINEMENT OF TAPER ATTACHMENT GRADUATION.

One of the useful American improvements of the engine lathe is the Slate taper attachment by which tapered work can be turned with the centers in line, coincident with the longitudinal axis of the lathe. The general construction of the taper attachment is too well known to require any description here beyond such general outline as will serve to make the following references clear:

Instead of setting the tailstock over, thus throwing the axis of the work out of parallel with the longitudinal travel of the carriage, a guide-bar, supported by suitable brackets on the back of the lathe bed, is used to produce the desired taper. The guide-bar is pivoted so that it may be swung through an arc of limited length, either side of the line parallel with the lathe axis, and provision is made for clamping it at any required setting. The guide-bar is made with parallel

TABLE I.

Taper per foot, measured Right Angles to Axis.	Included Angle.	Angle with Center Line.	Required Movement of Guide Bar Measured on Arc, Radius 13".	Actual Taper per foot when Arc is Evenly Graduated in Divisions of an Inch or Multiples of same.	Excess Taper per foot over that Indicated by the Reading.
Inches	Deg. Min. Sec.	Deg. Min. Sec.	Inches.	Inches.	
.50	2 23 10	1 11 35	.3123	.5003	.0003
.75	3 34 44	1 47 22	.4685	.7504	.0004
1.00	4 46 18	2 23 9	.6246	1.0010	.0010
1.50	7 9 10	3 34 35	.9363	1.5020	.0020
2.00	9 31 36	4 45 48	1.2470	2.0048	.0048
2.50	11 53 36	5 56 48	1.5568	2.5092	.0092
3.00	14 15 0	7 7 30	1.8653	3.0160	.0160
3.50	16 35 40	8 17 50	2.1721	3.5250	.0250
4.00	18 55 28	9 27 44	2.4771	4.0400	.0400

sides on which is fitted a slide connected with the auxiliary cross-slide on the carriage. In later constructions the attachment is made to the cross-slide nut, thus doing away with one slide and simplifying the construction. The guide bar being set out of parallel with the longitudinal carriage travel and remaining stationary, it causes the cross-slide and tool to travel toward or away from the center of the work as

TABLE II.

No. of Reamer.	Full Length.	Length of Flute.	Taper per foot.	Diameters.	
				Largest.	Smallest.
0	3¾	2¼	.624	.375	.258
1	5½	3	.600	.517	.369
2	7	3½	.602	.745	.572
3	8	4¼	.602	.989	.778
4	9	5¼	.623	1.29	1.020
5	10	6¼	.630	1.80	1.475
6	12	8½	.626	2.55	2.116
7	16	12	.623	3.373	2.750

the tool traverses it, thus causing the tool to turn a taper, the degree of which will depend upon the setting of the guide-bar.

Since it is common custom to designate different tapers in inches or fractions of an inch to one foot of axial length, instead of in degrees, it is the practice to graduate an arc over which the outer end of the guide-bar swings, so as to give direct readings. Thus if the machinist desires to turn a taper of ½ inch to the foot, he sets the datum line on the end of the guide-bar to the graduation marked ½ on the scale, and so on.

Now if the operator is careful to have his centers ground true and set dead in line, and to set the tool exactly on a level with the center of the work, the taper attachment should save much time in getting exact tapers, provided the graduations for the guide-bar setting are correct. But the usual practice is to graduate the arc in *equal* divisions to correspond to one-half the taper per foot multiplied by the ratio of guide-bar length to 12 inches. That is, if the guide-bar length is 15 inches from pivot to scale, the setting for, say, ¾ taper per foot, would be $\frac{3}{4} \times \frac{1}{2} \times \frac{15}{12} = 15\text{-}32$ inch

measured on the arc of the circle. But this is inaccurate since the even graduations expressed by any setting ratio, can only be laid off on the line tangent to the arc at the intersection of the line *CF*, Fig. 1. The taper per foot corresponds to the divisions on the tangents *AB*, which lie at right angles to the axis of the lathe. If, for example, the guide-bar was 12 inches long, the divisions on this line could be laid off in exact inch divisions, being marked for direct reading, of course, just double the actual length. Thus the ¼ inch line from zero would be marked ½, and so on. But, as stated, the graduations are laid off on the arc *DE*, and usually in equal divisions. Now since the equal divisions only properly exist on the tangent scale *AB*, the projections of these divisions must necessarily intercept parts on the arc which vary with the angle subtended by the axis of the guide-bar. When the angle is small the tangent and arc divisions are nearly equal, the differences being very minute, but as the angle increases the differences become marked. The change may be noted by referring to Table I. The lines *CK*, CK_1, CK_2, etc., in Fig. 1, indicate the position of the guide-bar for various settings up to 4 inches taper per foot.

The Bradford Machine Tool Co., of Cincinnati, Ohio, investigated this matter quite thoroughly some time ago, and, becoming convinced of the desirability of more accurate means for setting taper attachments than generally provided, they had "tangent" scales made by the Brown & Sharpe Manufacturing Co., which are now applied to all engine lathes built by them, having taper attachments.

The importance of having at hand accurate means for producing tapers on engine lathes to any required taper per foot, or to any angle, scarcely needs to be discussed here—it is too apparent. But as an example of the confusion and trouble that have been perpetuated because of using inaccurate methods in the past, we reproduce a table of Morse taper reamers, provided in blueprint form for use in the Bradford Company's shop, which, of course, they are obliged to follow when boring lathe spindles to Morse tapers. The Morse taper was, we believe, intended to be ⅝ inch (.625) per foot; the variation from this measurement may be noted in Table II. It is but fair, however, to state that the Brown & Sharpe standard taper of ½ inch (.500) per foot, varies in the case of No. 10, the taper in this case being .5161 inch per foot.

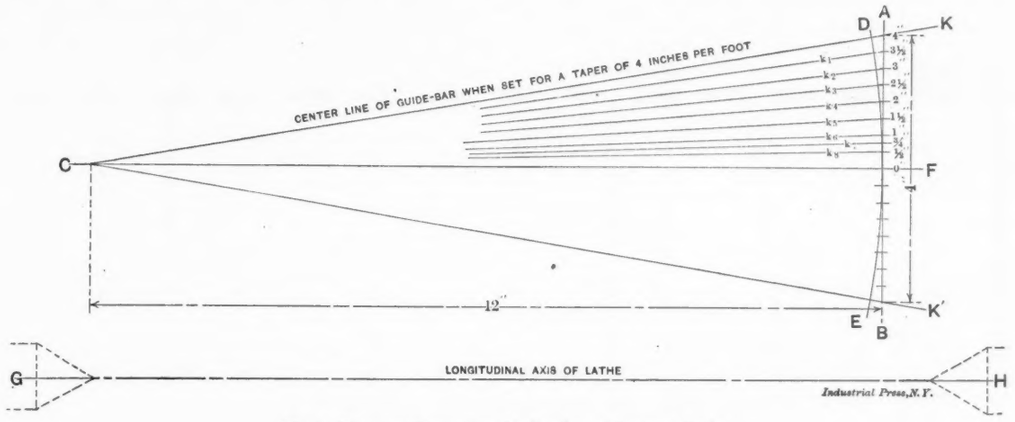


Fig. 1. Diagram Illustrating Application of Tangent Scale.

In addition to providing the corrected scales on taper attachments the Bradford Company expect soon to also graduate them in degrees, so that angles expressed in taper per foot or in circular measure, may be readily and accurately turned or bored by setting of the guide-bar to direct-reading scales.

* * *

Casehardening is a primitive steel-making process by which the surface of the pieces is enriched with carbon, putting it in condition to be hardened by sudden cooling. For hardening dies of complicated form, or most simple forms for that matter, casehardening usually gives more satisfactory results than plain hardening. Heating a piece of high-carbon steel in an open fire will very likely burn out some of the carbon, leaving it in a poor condition to harden when dipped. The casehardening process, on the contrary, enriches the surface with carbon and insures the maximum hardness at the surface where it is needed. It permits of the use of low-carbon steel which is cheaper and more easily worked. Another feature of the casehardening process that is particularly favorable to getting good results, is that the pieces being packed in a box and slowly heated, the heating is more uniform and the metal is protected from jets of cold air impinging against it, which we all know, is one of the difficult things to avoid in open forge heating.

SIZE LATHE	DIMENSIONS	
	A	B
14	10½	2⅞
16	14	4¾
18	15	5
21	14	5½
25	17½	6
28	24	8¼
31	21½	7
32	21½	7

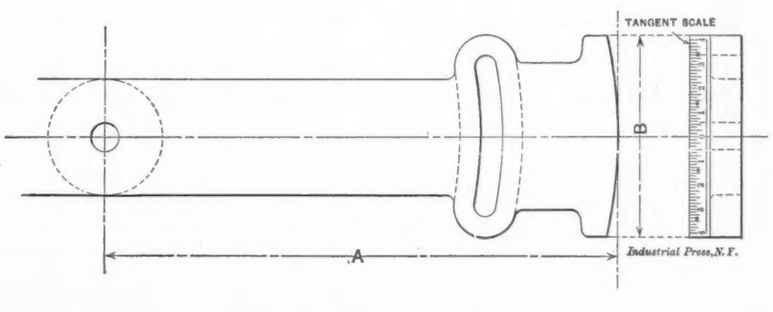


Fig. 2. Application of Tangent Scale to Bradford Lathe Taper Attachment.

These scales are screwed fast to the end of the sector plate, being bent to the arc of the required circle, as indicated in Fig. 2, and are made for the various sizes shown in the same figure. The divisions indicating tapers in even inches are exact, being projected from the inch divisions on the tangent, as already explained in the reference to the tangent *AB*, Fig. 1. The intermediate divisions are equally spaced; that is, the space between two adjacent inch marks are divided into eight equal parts. The error thus introduced is negligible; it is the accumulated error on wide angles that the corrected scale is designed to avoid.

MACHINE SHOP EQUIPMENT.—5.

EQUIPMENT OF THE IRON FOUNDRY.

OSCAR E. PERRIGO.

The equipment of the iron foundry necessarily differs in many respects from that of the other departments heretofore considered, as to its product, its work, and the necessary arrangements for carrying it on. These requirements, while they have changed much since the earlier plants for this work were established, have not perhaps undergone so great a change in a general way as have those of the machine shop. The early plants were, of course, very crude and primitive affairs, and iron was often melted in crucibles somewhat as brass is melted now. Most of the work done was of the plainest kind and little attention was paid to symmetrical or artistic effect.

1841. The proprietors of this foundry were Bowers & Pratt. A relative of the latter partner established a foundry in Wenham, Mass., and his son, at a later date built a foundry in Watertown, Mass., which was the original of the now well-known foundry of the firm of Walker & Pratt, for whom the writer had the privilege of making the first drawings of their heating apparatus to be reproduced by the original photo-engraving process invented by Moss, and operated by the Moss Photo-Engraving Company, on Park Place, New York City. Following the gradual development of the iron founding business from the early times is very interesting, but too long a story for the space of this article.

In these later years the addition of the traveling crane, the pneumatic hoist, the application of electricity, the iron flasks, the sand blast system for cleaning castings, and similar improvements have changed many of the older methods, and rendered the work less laborious and the output much larger. At the same time the quality of the work, both in its practical and in its artistic features, has been greatly improved.

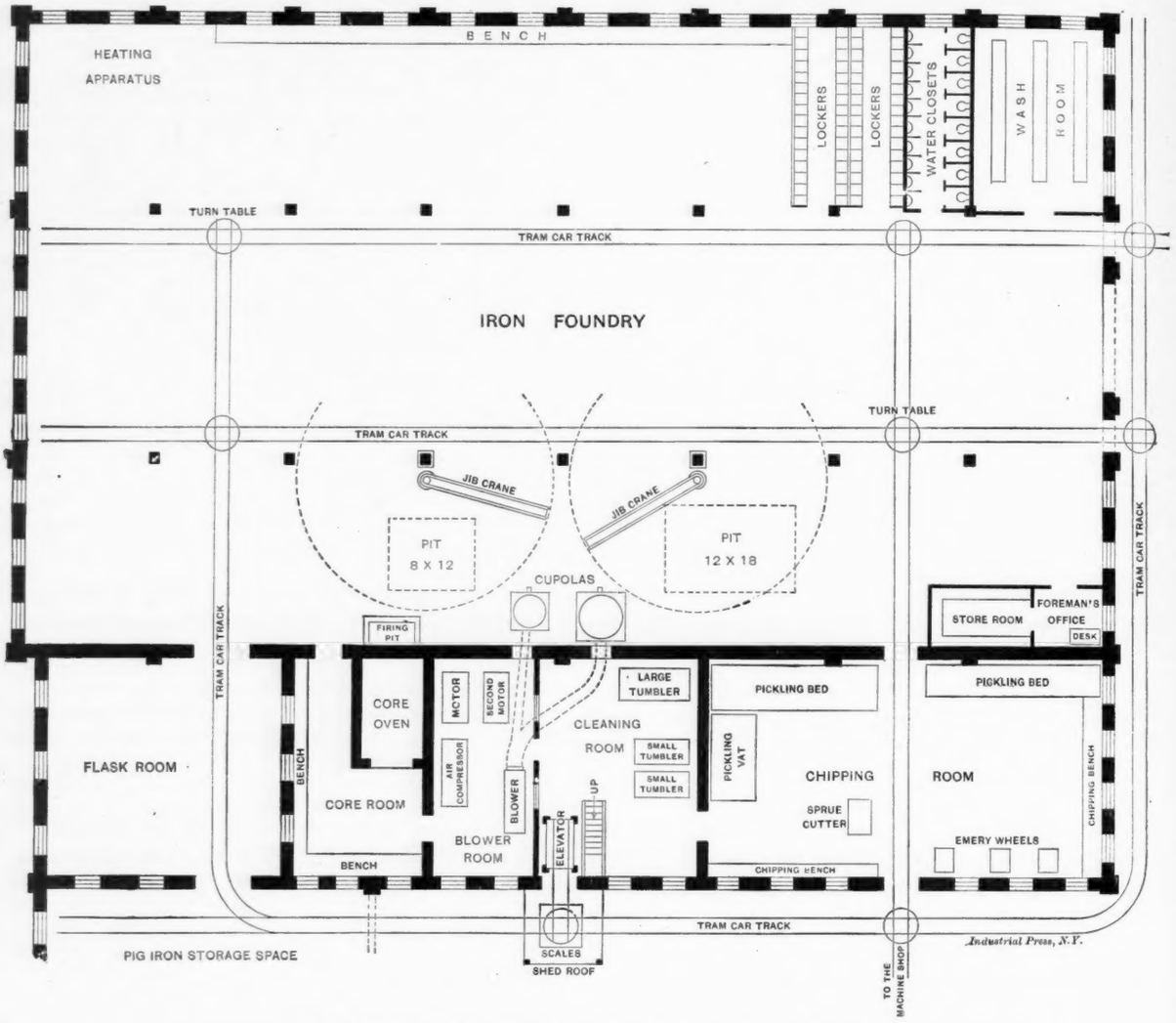


Fig. 1. Plan view of Foundry, showing General Arrangement and Equipment.

Early history shows that the making of iron castings was one of the oldest mechanical industries of the country. In the year 1643 John Winthrop arrived in this country from England, bringing with him the necessary number of skilled workmen for this purpose, and built a small iron foundry in Lynn, Mass., and the fact that the first casting which was made was "a small iron pot holding about a quart," shows the modest capacity of the foundry. The casting is said to have been made "from native ore."

Little progress seems to have been made in enlarging the original scope of the work from its early beginnings, so far as records of the facts are known. In 1735 an iron foundry was established in the little town of Carver, Mass., and a second one was built in the year 1760, wherein the historic Massachusetts Teakettle was cast.

Another foundry was built in 1793, and was burned down in

The foundry floor has been particularly described in the article on floors in the series on shop construction, MACHINERY, Vol. IX., to which the reader is referred for detailed information on this point.

Fig. 1 shows the general arrangement of the foundry and its equipment. The central portion is provided with a traveling crane, and under this and the two jib cranes shown, the heavy molding and casting are done. Tramcar tracks, located as shown, bring in any stock and material, such as sand, flasks, pig iron, coal, etc., as may be necessary, upon cars specially constructed to adapt them to each class of load to be carried. Turntables are provided at the intersection of the tracks, in

preference to curves and switches, as they occupy much less room, do not require any more time to operate, and the cost is nearly the same, for equipment offering like facilities. The special construction of these tracks and their accessories will be particularly described in a future article on shop transportation.

In bringing pig iron, coal, etc., to the cupolas the material is brought on the cars to the turntable scale in front of the elevator, and there it is weighed, then run upon the elevator, raised to the charging floor and the cars run upon the branch tracks, and thence to the cupolas, as shown in Fig. 2. The charging cars are specially constructed for this purpose, and are substantially the same as used by the Vilter Mfg. Company in their foundry in Milwaukee, Wis. A rear elevation of one of these cars is shown in Fig. 3, and a side elevation in Fig. 4. The frame consists of two similar iron castings for sides, held together by cast-iron cross rails bolted to them, as shown. The car body *A* is composed of two-inch planks, lined with sheet iron, and supported by wrought-iron, forged straps *B*, *B*, of U-shaped form, at the back and front, and by cast-iron angle supports *C*, *C*, near the center. Upon these supports are formed downwardly-projecting lugs, by means of which the car body is pivoted by the rod *D* to the frame, as shown in Fig. 4. The greater part of the load is placed back of this pivot, thus holding the car body in a horizontal position. Pivoted to the rear end of the car body is a rack *E*, engaging a pinion on a horizontal shaft *F*, which has fixed upon its front end spur gear *G*, engaging spur pinion *H* on the shaft *J*, which is squared on the front end for the application of a crank, by means of which the rear end of the car body may be raised and the contents of the car dumped. The dumping position is shown by dotted lines in Fig. 4. The car is of very simple construction; the gear and rack teeth are cast, the wheels and gears bored, and the hubs faced, but not turned on the outside. Several of these cars should be provided, so that there may be no waiting on the charging floor for either pig iron, scrap iron, coal or coke, during the progress of a heat, when time is valuable.

In Fig. 1 the location of the cupolas is shown, and also that of the blower and the blast pipes leading from the latter to the cupolas. A motor is also located in the blower room, which is used to furnish power to run the blower, and also the elevator, the tumbling barrels and the machines in the chipping room. It may be preferred to have two motors, one to be used only for running the blower, and run for a few hours only when a heat is on, and the other constantly, for driving the machinery above mentioned. These motors may be located side by side in the blower room, as shown. The blower may be placed on the floor, but it is often advisable to locate it overhead, out of the way of dirt and dust and more nearly on a level with the tuyeres of the cupolas, so that some of the curves in the blast pipes may be avoided, as this is a very important matter when the amount of air pressure is to be compared to the power necessary to generate it, as in this class of blowers it is considerably more than is generally supposed, even by good mechanics.

The motor, or one of them, may furnish power to operate the traveling crane by the old system of a square shaft running the length of the building beside it and so providing power at any point in its travel; but this method is a rather clumsy way to transmit power, and it is a much better system to have the traveling crane carry its own motor, the current being supplied to it by flexible, pendant cables near the wall and out of the way. These should be placed on the side of the building

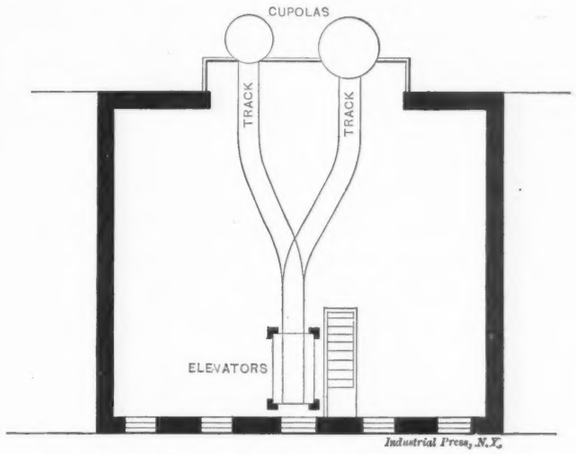
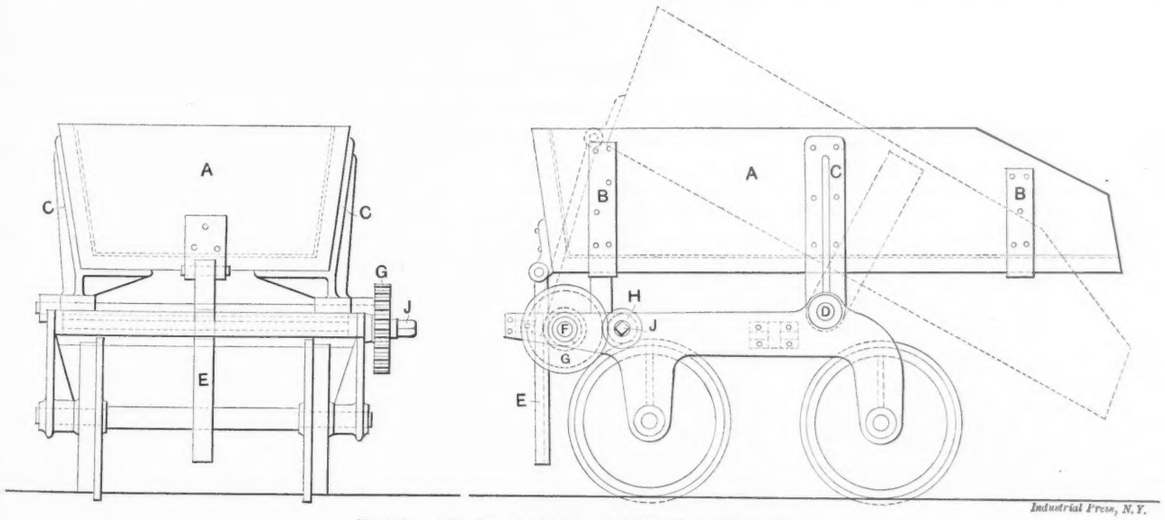


Fig. 2. Branch Tracks for Cars to run from Elevator to Cupola.

opposite the cupolas, where there will be no obstruction to them and where they will be away from the excessive heat.

The general molding floor of the foundry should have its work so arranged that the spaces outside of the supporting columns will be devoted to the lighter floor work and the bench work, where crane service is not needed. A bench is provided along one side as far as the heating apparatus (which occupies the outer front corner), for bench, or snap flask work. Here it will be found very convenient to use the compressed-air hoists for floor work, as it will be in other parts of the plant, as the hoists may be suspended overhead and used not only for drawing the deeper patterns but for turning over flasks, for it is now a demonstrated fact that in compressed air we have a very useful, convenient and efficient power, which may be utilized in the foundry, perhaps to as good or better advantage than in any other department of the modern manufacturing plant. Its uses are many, and the convenience with which it may be carried to any part of the floor for individual use, or for the lifting of quite heavy loads, renders it almost indispensable in the routine work of the foundry. The economy of its use may be readily appreciated when it is re-



Figs. 3 and 4. Rear and Side Elevation of Charging Cars.

membered that an air compressor provided with a cylinder six inches in diameter, and a storage tank three feet in diameter and five feet long, compressing air to 80 pounds per square inch, will furnish ample supply for a dozen hoists lifting 400 pounds or more each. In drawing patterns, turning small flasks, setting large cores and similar work, these hoists may be suspended in any desired location, the rubber hose attached bringing a supply of compressed air, easily controlled by a simple valve. These hoists may be suspended from a trolley traveling on an overhead beam, so located as to be convenient to the work. Of course, larger hoists may be used when necessary, and they are quite as effective and economical. Roughly speaking, a hoist with a 3-inch piston should lift 450 pounds; with a 4-inch piston, 800 pounds; with a 6-inch piston, 1,850 pounds; and with an 8-inch piston, 3,300 pounds. A supply of compressed air is very useful in the chipping room, where chipping tools may be very efficiently operated with it, and by its use one man may thereby do the work of at least two, and usually more.

An air compressor may be located in the blower room, as indicated in Fig. 1, and operated by the motor situated there. A cylinder 12 inches in diameter will be ample for the ordinary uses of the foundry floor and for operating such tools as are necessary in the chipping room. It will require a tank about 4 feet in diameter and 8 to 10 feet in length. This may be situated over the air compressor so as not to occupy the floor space. Such a tank should, of course, be constructed on the same lines and of like materials as a steam boiler of similar size, and to withstand the same pressure per square inch. It should be remembered that under ordinary circumstances if the air compressor is constructed on the plan of the boiler-feed pump, with a steam cylinder and an air cylinder, with one piston common to both, the proportions will be nearly these, viz.: steam cylinder, 6 x 8 inches, and air cylinder 10 x 8 inches. And also, that 90 pounds steam pressure will give about 65 pounds air pressure, with a piston velocity of 300 feet per minute. These figures are given as nearly correct and easily remembered.

A large variety of molding machines are in the market, many of which are admirably designed to turn out a large quantity of work in a day, and to save much of the manual labor usually necessary. They are, of course, employed on comparatively plain work where the tamping of the sand may be easily done by forcing down upon it a comparatively flat surface. They are usually employed upon the lighter kinds of work.

Molding machines are also made for molding the teeth of gear wheels of large dimensions, as well as large segments, and by their use much time is saved and the cost of large and expensive patterns for the gear teeth is avoided. There are also molding machines for pulleys, which are valuable as a part of the foundry equipment, and with a proper supply of rims and spiders this work is much simplified and the costs reduced.

These machines must be selected and provided in accordance with the particular class of work to be done, as their utility will depend almost entirely upon this matter.

Sand sifters and sand mixers are now made so as to be mounted upon a tram car and are driven by a small electric motor attached to them, the machine being thus rendered complete in itself, and may be easily moved to any part of the foundry desired, and when not in use, run out of the way. They will be found very convenient on nearly all classes of work, and may supersede the usual hand riddles almost entirely, saving much of the molder's time and producing better castings, as more sifted sand is likely to be used if the molder is not obliged to sift it by hand. Besides, being sifted close at hand, it is not so liable to contain foreign matter, as if it is sifted at one point and carried to different parts of the foundry where it may be needed.

The deep molding pits are located as shown by dotted lines in Fig. 1, one, 8 x 12 feet, and the other 12 x 18 feet. These may be of any required depth, but more usually the smaller one would be about 5 feet, and the larger one about 8 feet. All of these dimensions should, of course, be made according to the character, size and the weight of the larger castings to be made. The walls and floors of the pits should be constructed according to the directions given in the article on shop floor construction, which preceded this series. These pits will be found very useful in molding large pieces wherein a very deep nowel flask would be required, and which would necessarily raise them several feet higher on the floor than would be the case where a pit is made use of. Such pieces, which may not be cast on their side, and weighing, say, over 4 tons, will usually be found fit subjects for pit molding.

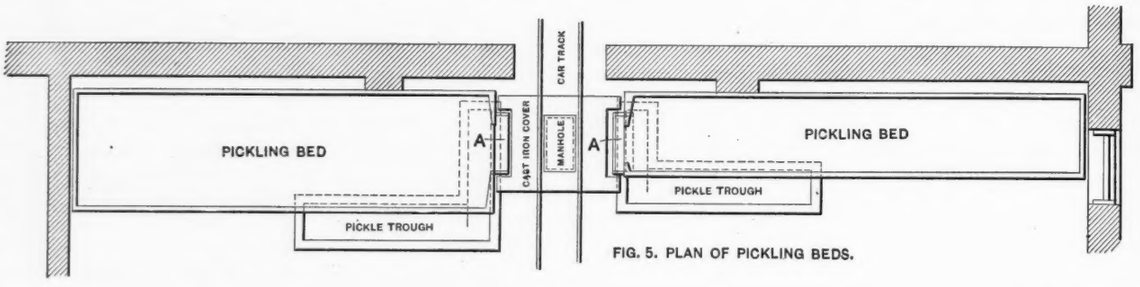


FIG. 5. PLAN OF PICKLING BEDS.

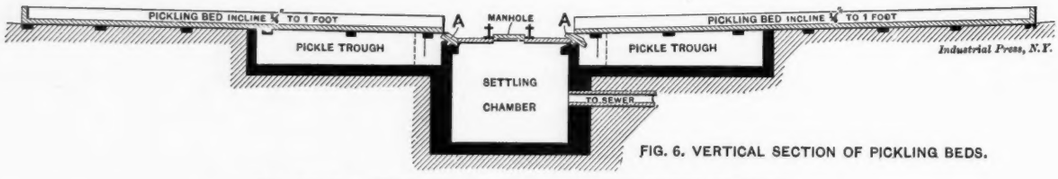


FIG. 6. VERTICAL SECTION OF PICKLING BEDS.

Figs. 5 and 6. Pickling Beds—a new and Efficient Method of Pickling.

It will be noticed that the cupolas have been located within the space of the foundry proper. This, of course, will occupy considerable room on the foundry floor. They are so placed in many foundries, this being a more desirable location in several respects. In this case they come nearer to the cranes, which are supported from the main columns, and afford a convenient means of transferring a ladle of melted iron from the cupola front to the cars, and thence by the track to any point in the foundry, or, from the cranes over to the traveling crane and thence to any part of the central space of the floor. The cupolas may be located in the cleaning room and the blower room space, and thereby save about 140 square feet of molding floor space. In this case the cranes will be placed closer to the wall, but yet with sufficient reach to pass ladles of melted iron to the car track, or to the traveling crane. If this disposition is made the location of the tumbling barrels will need to be changed, placing one at the front of the room. If it is found necessary, the motors and the air compressor may be placed on the charging floor, where there is ample room for them. Even the blower may be located there, for the purpose of affording more space on the first floor, a partition dividing them from the charging floor proper. The stairs also may be placed at right angles to their position as

shown, for the purpose of affording any specially desired location for the first floor equipment. In case the cupolas are placed in the cleaning room and blower room space, it may be advisable to run a car track immediately in front of them, connecting at each end with the transverse tracks by the usual turntables, and by which means ladles of melted iron may be transferred to the central space under the traveling crane by taking the route either to the right or left, as may be the shorter distance. However, many will prefer the jib crane for this service, as being quick, efficient and safe.

In the back corner of the main part of the foundry proper is the foreman's office, and adjoining it is a store room for the various small articles, tools, etc., necessary for almost daily issue, and which the foreman of a foundry of this size will probably find necessary to have under his personal control; although it will be advisable to have an employee in the office who is conversant with these matters, and to act as a bookkeeper, in order that the foreman's time may not be too much taken up with these matters of routine details.

In the front corner, on the outer side, is located the heating apparatus, which has been previously described in the general article on heating, in the series on shop construction. If preferred, it might as well be located in the corner next to the flask room. This would be convenient if more bench room was required for snap flask work.

castings upon it. Very heavy castings may rest upon pieces of board laid upon the lead for its protection. The lead should not be thinner than an eighth of an inch for ordinary uses. The pickle bed inclines toward the drainage system a quarter of an inch to the foot. The pickling solution or wash water dripping from the castings upon the pickling bed flows to the lower end, and upon a narrow tilting table *A*, which directs its course as may be desired. In the position shown on the right of the drawing it will run the pickling solution into a transverse conduit, from which it flows into the pickle trough, where it may be dipped up to put on other castings. When the castings are sufficiently pickled and it is desired to wash them, the hose is brought into use and the tilting table *A* is placed in the position shown on the left in Fig. 6, and the wash water flows into the settling chamber. Considerably above the bottom of this chamber a drainage pipe leads to the sewer. All sand or scale which passes down from the washing process drops to the bottom of the settling chamber, from whence it is cleared out as often as necessary through the manhole between the car tracks, as shown. A cast-iron plate covers the settling chamber, supporting the car tracks passing over it, as well as the manhole cover.

Near the pickling beds is located the pickling vat, in which small castings may be immersed until sufficiently pickled, then placed upon the pickling beds to drain and be washed. This

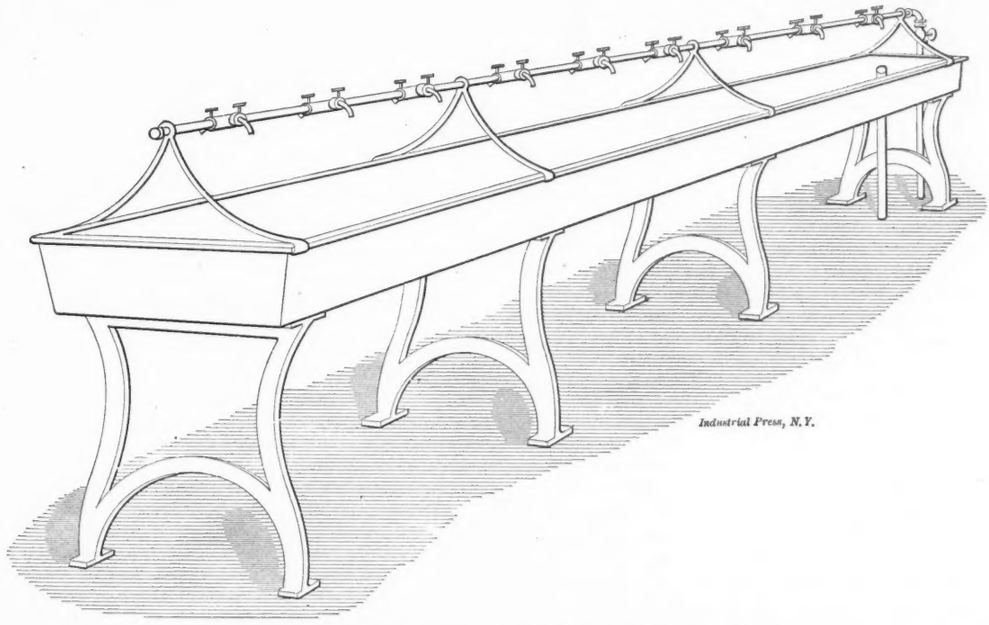


Fig. 7. Cast-iron Washing Sinks, with Individual Supply of Water.

The chipping room is provided with the usual benches, having a sufficient number of vises on them to accommodate the work requiring hand chipping. Sprues are cut off in the sprue cutter where this can be done by such a machine. The three emery wheels will do much of the small finishing on the castings, while the pneumatic chipping tools will do very much of the work on the heavy castings.

Pickling beds are provided for, as shown on the plan, Fig. 1. These should be so constructed that the pickling solution may drain off into a receptacle where it may be saved and used again, while the water used in washing the castings after pickling, and the burned sand and scale coming from the castings, will go into another receptacle, where the sand and scale may be retained and the water flow into the sewer.

A very efficient method of accomplishing these results is in use in the new foundry of the Brown & Sharpe Mfg. Company, Providence, R. I., and with some necessary modification, it is shown on enlarged scale in the plan Fig. 5, and in vertical, longitudinal section in Fig. 6. The pickling beds are built of 2-inch plank, supported on timbers 4 x 6 inches, placed not over 4 feet centers, and have at both sides and at the upper end a plank 8 inches high. This bed is lined with sheet lead of sufficient thickness to not be easily cut through by laying is constructed of planks and lined with lead, the same as the pickling beds. Concrete construction may be used if desired.

An overhead trolley and hoist should be placed over the pickling beds, for removing castings from the cars and transferring them to the bed on the right or left, as may be desired, and back to the car when they are finally washed. Another similar overhead trolley should be placed in the center of the room for lifting castings to and from the floor and cars. These two trolley beams may be connected if desired, and run as one system. The hoists may be operated by compressed air, in the same manner as those in the foundry proper. If the sand blast process is to be used for cleaning castings it will be necessary to enclose a space of sufficient size in which to operate it, in order to prevent the disagreeable dust created by its use, provided the high velocity usually used is to be arranged for. There is, however, a sand blast apparatus made in Germany which uses a very coarse sand at a comparatively low velocity, which appears to be a success, and does not require to be operated in a close room.

The core room is provided with benches on two sides, and the usual form of core oven, which is fired from a pit formed in the floor of the foundry proper, by which arrangement the entire height from the core room floor is utilized for the cars

upon which the cores are arranged and run into the oven from the floor level. The core oven may have its entire front closed with sheet-iron doors, running up out of the way; and upon the inner sides of the oven walls a series of supporting bars, permitting cars to run in, one above the other, their front ends being suspended on overhead trolley beams when they are drawn out. By this means the upper portions of the core oven may be better utilized and smaller lots of cores may be run in and baked at a time; or, the oven may be divided by a vertical partition and one side used for a large car, filling the entire space, and the other side arranged with shelf-like cars or racks, for small lots of cores. Separate doors should be provided to close each section so as not to expose one section to cold air when cores are to be put in or taken out of the other. By this arrangement much more work may be baked than if the whole front is to be opened at once. The doors may swing upon hinges if there is a lack of height for

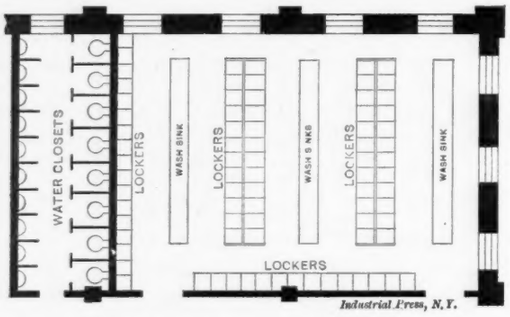


Fig. 8. Showing Arrangement of Wash Room.

lifting doors, although the latter, properly balanced, form a very convenient arrangement, and not in the way when the doors are opened.

The flask room requires no special arrangement or equipment beyond the car track and its cars for carrying flasks to and from the molding floor, unless a very considerable number of the flasks are of small and medium sizes, when they might be conveniently stored upon a gallery floor, which might extend nearly around the room. Flasks could be quickly and conveniently passed to and from this gallery by means of a pneumatic hoist. By this means the storage capacity of the room could be increased at least fifty per cent., perhaps more.

The wash room is located in one of the outer corners of the foundry proper, as shown in Fig. 1, and has adjoining it the water closets, and next to these the lockers for the use of the employees. The washing sinks are of cast-iron and arranged with an individual supply of water from a pipe running along above them. One of these sinks is shown in perspective in Fig. 7. By this method of water supply each man may have clean water, and still the expense of separate wash bowls is avoided. The plentiful supply of fresh water is nearly always appreciated by the men, although the writer once knew of a shop in which a similar arrangement for their cleanliness was made and the men refused to use it, preferring to wash in the common pool of not over-clean water in which all the rest of the force did the same. It has been said that "there is no accounting for taste," and this may be a case in point. Certain it is that the well-meant efforts of shop owners and managers are not always appreciated by the employees.

The water closets are arranged with a row of separate closets on one side, and a row of urinals on the other, the latter having dividing partitions 24 inches wide, while the depth of the closets is 3 feet 6 inches, and each is provided with a swinging door hung with double spring butts. The closets should be arranged so as to flush automatically, and a continual supply of running water provided for the urinals.

The lockers are of expanded metal, and are of the usual dimensions for such use, that is, 12 inches deep, 18 inches wide and 72 inches high. The width might be decreased to 15 inches and still provide ample room. They are placed in rows facing each other, with the two rows in the center back to back, for economy of space. In the plan just described it will be noticed that the lockers, the wash room and the water closets are each separated from the other. In some respects this is not as convenient as it will be to have the lockers arranged in the wash room. Such a plan is shown in Fig. 8. The amount of space and the expense necessary are about the same in either case, but the latter arrangement will probably be preferred by the employees generally, as being more convenient to have their lockers near where they are to wash up, and it will cause less confusion in running back and forth from one to the other, at a time when everyone is in a hurry to wash, dress and get out in the shortest possible time.

* * *

DEEP DRILLING.

FRANK B. KLEINHANS.

It has always been an expensive operation to drill out the interior of a hollow spindle. Indeed, it has not only been an expensive operation, but, on account of the spindle being of high-carbon steel, it has also been a difficult operation. Thus we have placed on the market hollow-drawn tubing, such as the Shelby tubing, which is intended to be furnished at a less price than one can bore out the interior of a solid bar. Of course for some purposes this tubing answers very well. But there are many cases, as in certain kinds of spindles, where such tubing cannot be used. We are obliged, therefore, to bore out this metal as best we can and endure the expense, whatever it may amount to.

Nearly all lathes nowadays must be built with a hollow spindle. This is also true of spindles of boring machines, drill presses, etc., and thus we have a large variety of work on machinery which involves deep drilling. The cost of deep drilling has been greatly reduced recently, by several manufacturers, by means of what may be termed a hollow drill. A strong flow of oil is forced through this drill against the cut, and on its return carries the chips with it, thus performing the double function of keeping the drill cool and clearing out the chips.

A perspective view of one of these drills fitted up complete for work, is indicated in Fig. 1. The body of the drill, *B*, is made of machine steel. The point, *P*, is made tool steel, and is held in position by the taper pin, *T*. A hole, *H*, is drilled in the shank, and from this hole the oil

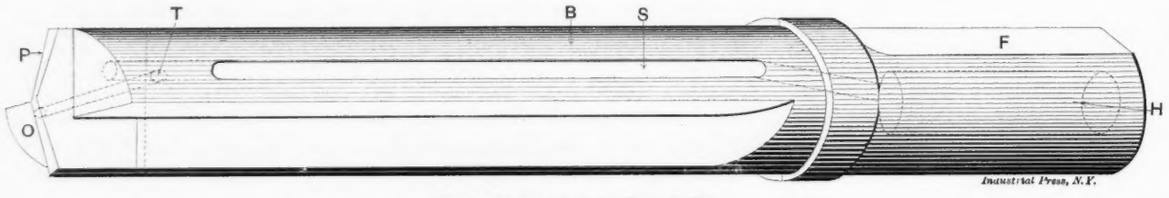


Fig. 1. Oil-tube Drill for Deep Drilling.

is led to slots, *S*, which are milled along the outside. These slots run the full length of the drill and then shoot down at the ends, as indicated. *F* is a flat spot for holding the drill.

A longitudinal sectional view of this drill is shown in Fig. 2, from which the construction of the passageway for the oil is better seen. *H*, again, is the oil inlet hole already referred to. Two small holes, *J*, *J'*, are drilled into it in the manner indicated in this figure. The holes, *K*. *K'*, are then beveled off, and a piece of brass tube is bent in the arc of a circle and the ends are entered into the holes, *J*, *J'* and *K*. *K'*. It is then hammered down into place and the joint is flushed with solder. The slot, *P*, is milled out so as to have a semicircular bottom. Into this slot the cutter of the drill is neatly fitted. These points are best

made of Novo steel, as they hold up better than under high speed. They are made as shown in Fig. 3. The hole, *H*, is reamed through the drill, while the cutter is clamped firmly back against its seat at the end of the slot. The angle, *A*, is made about 20 degrees. The cutting edge is nicked at several places, as at *N*, in order to break up the chips, this being done on the corner of an emery wheel. After the drill is put into place, it is ground up accurately to the diameter, *D*.

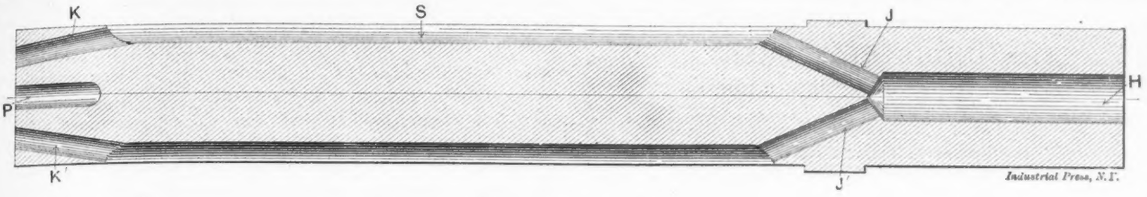


Fig. 2. Section of Drill.

The arrangement of a machine for boring out lathe spindles with this drill is shown in the illustration in Fig. 4. Instead of the long slide and hexagonal turret, a special slide, *A*, is provided, which is shaped up at the end to receive the drills. *B* is a steady-rest and *S* is the spindle. A lathe carrier is screwed into the end of the spindle, as shown, and a plate, *P*, holds the spindle up against the center by means of a few bolts. *C* is a Brown & Sharpe No. 2 pump, which is belted up to run 350 revolutions per minute. This gives an ample supply of oil for drilling a three-inch hole. A flexible tube leads from the pump to the fitting, *F*, and from thence the oil enters the spindle. The trays, *T*, *T*, catch the oil, and from these trays a pipe leads to the suction side of the pump. The drill is made long enough so as to run a short distance beyond the middle of the spindle to be drilled, the spindle being then turned round and drilled from the other end. With a drill made up in the manner explained, it is possible to drill a 1 5-16 diameter hole in a .40 carbon spindle at the rate of 1⅜ inches per minute. The cutting speed would be 60 feet per minute on the longest diameter of the drill. We would thus remove the following amount of metal in a day of ten hours:

$$\frac{1.353 \times 11 \times 60 \times 10 \times .28}{8} = 312.5 \text{ pounds.}$$

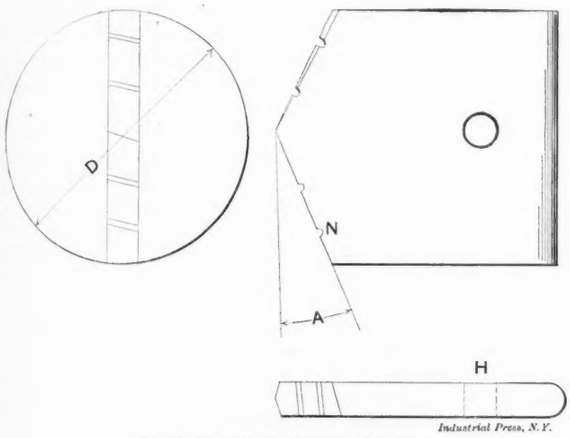


Fig. 3. Steel Cutter for Oil-tube Drill.

By this method, a bar 28 inches in length can be drilled out at less cost than we can obtain the cold-drawn tubing of the same size.

* * *

Most failures of amateurs in machine shop photography arise from insufficient exposure. The result is a thin negative having poor printing qualities. The best thing to do under such conditions, is, of course, to take another picture, giving longer exposure or using a larger stop, but this is not always feasible. In such cases it is possible to improve the printing effect by making a transparency, using plates covered with lantern-slide emulsion, that is, plates that are specially prepared for making lantern slides. The transparency is made with the two plates placed with their faces in contact, and held in a printing frame so that the register may afterward be exactly duplicated. This is simply done by pressing each into the same corner so that a side and end are in contact with the ledges. When the transparency has been developed, fixed and dried, it is used in connection with the negative for making prints, being placed in the printing frame first, followed by the negative which is, of course, disposed in the ordinary manner with reference to the printing paper. The transparency being the exact opposite of the negative, has the effect of reducing the high lights and giving the shadows time to print the fullest possible detail.

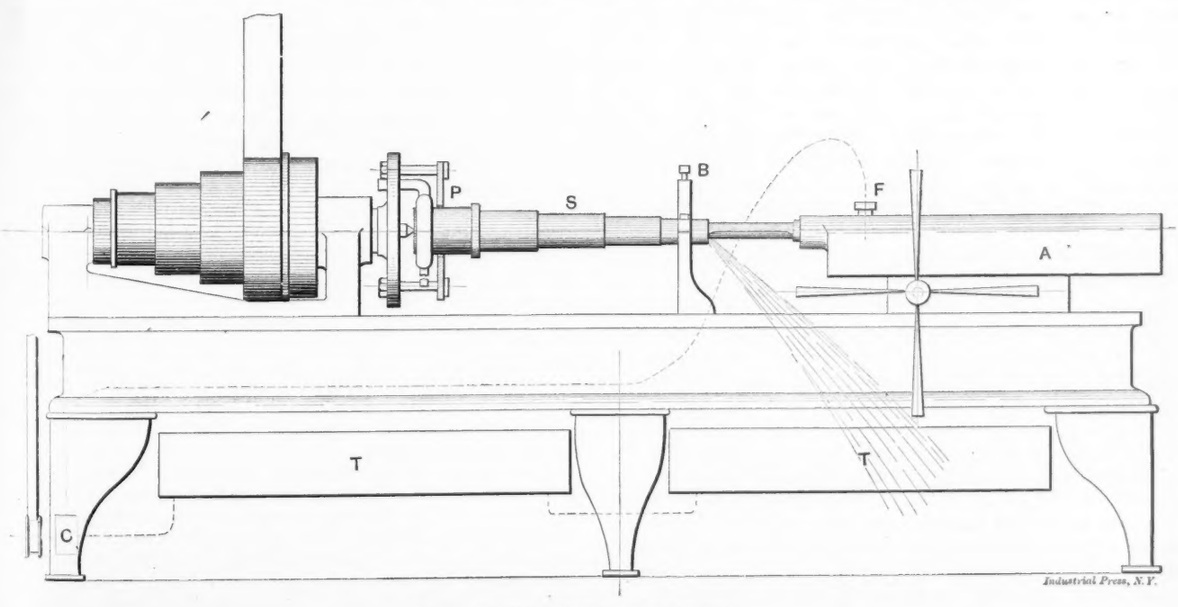


Fig. 4. Diagram of Lathe for Deep Drilling.

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MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1904.

NET CIRCULATION FOR DECEMBER, 1903,—27,217 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition, and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

Mr. George H. Hall has resigned from the editorial department of MACHINERY to again take up the work of constructive engineering. He is to be connected with the Crocker-Wheeler Company, Ampere, N. J., and carries with him the friendship and best wishes of his associates in this office.

* * *

PRESIDENT DODGE'S ADDRESS.

Mr. James M. Dodge's presidential address before the American Society of Mechanical Engineers, upon "The Money Value of Technical Training," should make pleasant reading for a young man who is trying to improve his opportunities for self-advancement. It should strengthen his confidence in himself and in his future.

Mr. Dodge believes that education pays. We probably all believe that it pays, provided the education is of the right kind and does not absorb too many of the best years of a young man's life. But the interesting thing about Mr. Dodge's paper is that he backs up his belief by statistics which demonstrate, so far as his investigations have gone, that education pays in dollars and cents. He went at the subject in a business-like manner, by selecting four groups of men, between whom comparisons of progress and advancement were to be made, and his final conclusions were derived from the average attainments of the men in each group. The first group was composed of unskilled workers or laborers; the second of shop-trained mechanics; the third of mechanics trained in schools of mechanic arts; and the fourth of technical graduates.

A statement of the manner in which the data were gathered was purposely omitted by Mr. Dodge so as to divert the discussion of his address from this feature to the more profitable question of actual results accomplished by technical training. The figures were obtained, however, in the main from the records of the Link Belt Engineering Company, Philadelphia, of which Mr. Dodge is president. The statistics of laborers represent the records of about ten years and are the averages of at least 200 men. Those of mechanics who have grown up in the shop cover a like period and were derived from about 150 men. The trade school statistics are based upon the record of 24 men selected at random from about 50 men. Those with regard to technical graduates are based on records of about 80 men who are or have been in the employ of the company. Considerable pains were taken to verify the figures by comparing them with those obtained in other establishments.

Taking the average results from each of these groups, Mr. Dodge has plotted a diagram indicating the rate and extent of advancement of each class of employees, from which we draw the following general conclusions:

The pay of the average laborer rises steadily until at 22 years of age he receives about $10 a week; and there it remains. He apparently has no resources, no initiative, no reserve to draw on to enable him to climb higher.

When we come to the shop-trained mechanic we find that his wages advance in a similar manner, but he rises higher. He has a trade to help him and does not arrive at the stationary period of wages until 24 years old, when he receives $15.80.

The trade school group averages to reach $12 a week at 19 years and $22 at 25 years. From this point on the wages do not remain stationary, as in the other two cases, although the rate of increase is small; but it is enough to indicate that the education of the trade school is of permanent help to a man in securing advancement, while a trade alone, without the education, will not, on the average, provide the means for advancing beyond a certain point.

Finally, the technical group, which advances rather slowly at first, shoots ahead rapidly after a few years and continues to climb—perhaps indefinitely. At 18 years the technical man receives only $4 a week, and at 24 years $18, but at 30 years he receives $41. As a matter of course both the trade school and technical men will at some time reach "high-water mark," beyond which their pay will not rise, but there were no statistics to indicate where these points are and it is doubtful if they could be determined.

The lesson to be learned from Mr. Dodge's address is not that a course of study will enable one to receive a stated sum of money at a certain age, and it would be wrong to assume that a course of technical study would necessarily qualify a man to draw 25 or 30 or 41 dollars a week; or even that he would receive these amounts if he were qualified. Neither is it an argument showing that a shop man may not earn several times 41 dollars a week, without even any education at all, if he has the opportunity and ability. Advancement really depends upon two things: First, outside conditions, such as the state of the labor market, influence of friends, chance opportunities, etc.; and second, the inside conditions, or what the man himself is or what his abilities are. One may and often does secure a position through outside conditions; but it generally requires ability to hold it, and Mr. Dodge has gone one step farther and has shown pretty conclusively that in the long run and on the average it requires not only ability, but knowledge to hold a good position. As he expresses it, "Trained common sense receives the greatest compensation and reaps the greatest reward," and he very aptly says, "Every man pays for the amount or percentage of bossing he requires."

It is to be hoped that other manufacturers, with statistics at their disposal relating to their employees, will have results tabulated, similar to those quoted, so that we may know whether the effects noted by Mr. Dodge in the comparatively small groups observed, actually hold in larger groups, composed of men engaged in varied lines of industry. Such a test would give the surest indication of the commercial value of education.

* * *

The manufacture of metal planers presents an almost ideal example of planer work—the platen. Naturally the tool builders making planers present a first-class showing on planer work in their own shops. Two tools working on a platen as large as that of the machine planing it, is an impressive sight, as is also the pile of cast iron chips removed in a regular day's work. In the shop of the Cincinnati Planer Company the platens are first roughed top and bottom and on the sides, and the T-slots are also roughed at the same time.

The platens are then taken to the drill press and the holes drilled for the stakes, using Novo steel twist drills running at high speed, the speed for a 1-inch drill being about 280 turns per minute. Drilling the platens before the finishing is done gives the internal stresses in the castings a chance to readjust themselves, thus preventing final changes after the finishing cuts are taken. After the finishing cuts have been planed the ways are scraped and fitted to the Vees and lastly the final finishing cut of a platen is taken on its own bed, driven by its own mechanism when being tested.

NOTES AND COMMENT.

A treatise has recently been issued, called "Technical Mechanics." The Standard Dictionary defines the word technical as "specially or exclusively pertaining to some particular art, science, trade, occupation, or the like." Mechanics is at least a branch of science, if not a science itself; so, What would non-technical mechanics be? Now let us have a treatise on medical pharmaceutics.

A number of manufacturing concerns in this country now provide their employees with a warm lunch at noon, or furnish dining room facilities where they can eat lunches brought from home in comfortable surroundings and add to the *menu* certain items like soup or coffee supplied by the company at nominal prices. This is not done as an act of charity, but is a matter of good business policy. The increased energy and better health resulting from a warm substantial noonday meal, especially with female help, has been found to more than pay the cost of such undertakings. The well-known National Cash Register Works at Dayton, Ohio, now feed about 550 girls daily, and it is their plan to eventually provide dining facilities for all their employees, who number about 4,700, during the busy season. A big catering job, that!

Notwithstanding all the arguments in favor of the worm gear, the fact remains that it is much more likely to be abused than spur gearing. The latter *can* run without oil, and, of course, in almost every instance it is better for it to do so, but worm gearing must have oil, or it will soon wear out. While it may be argued that anyone in charge of worm gearing, would run it in a bath of oil if he had any mechanical sense at all, the fact remains that machines of this type have been ruined simply by not being properly oiled. We well remember a large worm-driven butting machine installed in a structural iron works for facing off the end of cast iron columns. A pan beneath the worm, forming part of the machine, was a mute appeal for plenty of that which lubricates, but the machine was run at a period of about six months with "nary" a drop of oil in the pan, and only an occasional drizzle on the gearing, with the result that the wormwheel was nearly worn out in that period.

A not unusual procedure and perhaps the most common method of setting a gear cutting machine, is to do so by making a trial cut and measuring the height of the tooth with a gear tooth caliper. The result by this method may be right if the outside diameter of the blank is right, but if it varies a few thousandths from the correct diameter, the variation may make a noisy running gear. Again it is not the easiest matter in the world to get a correct setting in this way, even with a correctly sized blank. The Cincinnati Planer Company provide cast iron blanks, mounted on permanent arbors, for setting their gear cutting machines, which are carefully ground to the correct root diameter of the required gear. The operator places the setting blank upon the index centers and raises the cutter until it just skims the surface, which has been covered with a light coating of red lead. The setting made in this manner is very accurate, being easily within a limit of one-half thousandth inch. If the operator happens to score the surface of the setting blank it is not ruined since obviously any untouched portion of its surface can be used for setting purposes.

There are two ways of handling mechanical difficulties—one by surmounting them, the other by going around them. A well-known mechanical engineer says that sorrow and vexation of spirit is almost invariably the lot of the engineer who attempts the first mode of solution and that the easiest, and usually the best way is to solve them by not solving them, that is, by using some other expedient equally as good, but free from the objection of the other. A case in point is that of the Manhattan Elevated Railway in New York, now a portion of the Interborough system, in regard to the third-rail difficulties in snow and sleet storms. The officials are trying to surmount the difficulty by removing the accumulations of sleet by scrapers, etc. One device of this nature is now being tried and has been found moderately successful. But its action is accompanied by a distracting screech, and it is quite doubtful if it will work successfully under severe weather conditions. The device does *not* remove the difficulty permanently—it works Sisyphus-like at a never-ending task so long as sleet is falling. The logical way of handling this problem is by preventing all accumulation of sleet on the third rail. A hooded construction presents a simple and readily built protection which has been found to successfully cope with the snow and sleet trouble in a location far worse than that of New York City.

MACHINE WORK VS. FORGING.

One of the largest steel companies in the country is employing high-speed steel for reducing forgings in a way to open the eyes even of those conversant with the rapid lathe work done in many of our machine shops. This steel company has special lathes for reducing rough forgings to the rough-turned size suitable for shipping to customers, and we are reliably informed that these lathes are of sufficient power and can carry enough cutting tools for simultaneous turning, to remove what is estimated to be thirty times the weight of metal that an ordinary heavy lathe of the same swing would be capable of turning off. The use of such massive and powerful tools, and the introduction of high-speed steels, have brought about a new condition in the production of these high-grade forgings, in that after being roughly formed from the ingot they can be reduced to approximate size more rapidly and far more cheaply by turning in a heavy forged lathe than by forging down to size under the hammer or hydraulic press. An instance has been cited to us of a forging that was reduced from 36 to 28 inches in diameter by one man working at the lathe for two days, where a gang of workmen would have been required for perhaps a day at the forge and hammer by the old method. And not only would the labor cost have been greater, but the forge and hammer would have been tied up during this time and a great quantity of fuel would have been wasted.

ELECTRICITY DIRECT FROM FUEL.

Ever since, and even before, the period when the potential force of electricity was generally recognized as a factor of great commercial value the dream of the engineer was to generate it direct from fuel without recourse to the present cumbersome and wasteful process. With the steam boiler, engine and dynamo the fuel must be fed into a furnace, where, if it is not already in a gaseous condition, it gasifies and burns at a high temperature—the higher the better, the average firebox temperature being from 2,200 to 2,500 degrees F. or more. The heat thus produced is transmitted through the shell and tubes of the boiler to the contained water which is changed into steam under pressure. By virtue of its latent heat and pressure the steam impels the piston and its energy is converted into rotary motion. Still another conversion is made in the dynamo to supply the electric current. All this is costly and inefficient, as we all know only too well. The best stationary steam plants that we know of cannot show an efficiency of one indicated horse power per pound of coal per hour, although some closely approach it. But this figure is absurdly wasteful, the thermal efficiency being only about 19 per cent., and with the best gas engines it does not appear possible to show an average efficiency of much more than 25 per cent. The efficiency of the average commercial steam plant is said to be only about 8½ per cent., and perhaps this figure is high. It is not surprising, therefore, that many of the best inventive minds have been working on the problem of direct heat conversion, the theoretical possibility of which has generally been conceded, but which has presented most formidable and baffling difficulties to a practical solution.

* * *

In a recent number N. C. B. contributed a note about different coatings for a shaft when it is necessary to pour a solid babbitt bearing around it. Mr. J. C. Green, Hackettstown, N. J., writes that he has used a simple method for years past. It is simply to rub the shaft sparingly with hard soap before pouring the bearing. He has found this plan very successful.

MEASURING EXTERNAL THREAD DIAMETERS.

METHOD OF THREAD MEASUREMENT BY MEANS OF WIRES AND MICROMETERS.

JOSEPH M. STABEL.

No doubt many mechanics who have to do with the making of taps, thread plugs and rings, often find it difficult to get accurate fits by using the tops of V-threads as points from which to obtain their measurements. Errors are almost sure to exist when measuring from the tops of the threads—points which in one sense of the word have no value at all. As is well known, the bearing of a thread is on its side and that is where a perfect fit is required. Some take it for granted that if the measurement over the tops of the threads, and that at the root, are correct the thread cannot help being a perfect fit, and no doubt they are right provided the root diameter is measured properly and the sides of the teeth are cut at exactly the right angle.

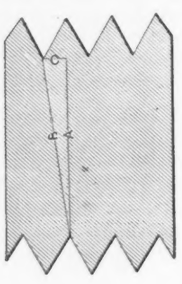


Fig. 1.

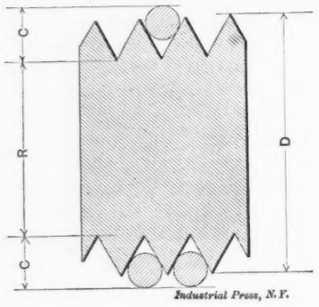


Fig. 3.

In obtaining the root diameter it is customary to divide the constant 1.732 by the pitch of the thread, and this gives the diameter of the cylinder upon which the threads are formed, but it is impossible to measure this diameter directly, as will be seen in Fig. 1. If this is a ½ inch 12 thread screw the core diameter will be $\frac{1.732}{12} = .1443 +$ and $.500 - .1443 = .3557$, which is a measurement that must be made at right angles with the center line of the screw; an impossibility unless a pilot is turned on each piece that is to be threaded, and the thread then cut down until it comes in contact with the pilot. This, however, is not a practical method, and can seldom be followed. As will be seen in the figure the line *B* indicates the angle at which the calipers would be set in measuring this thread and it will be easily seen to be longer than the line *A*, which indicates the actual core diameter. Should the core diameter be measured on the line *B* it would be equal .3582. So when measuring the root diameter of any screw, as on the line *B*, we would have to discard the constant 1.732 and use the formula $B = \sqrt{A^2 + C^2}$.

Measuring at the top and root of the thread, however, does not always insure an accurate size of screw, as the sides of the threads may be convex or concave, thereby giving a thread that is thicker or thinner than it should be. In such a case the screw would not fit the female threaded ring properly even though the external and root diameters were accurate in size. So the method here described has been found a much more satisfactory way of measuring screw threads than by the method of measuring the apexes of the thread diameters. The measurements are accomplished by the aid of short pieces of round wire, different diameters being employed for the various pitches of threads. Fig. 2 shows the method in use and illustrates a neat fixture that is adapted to the purpose. It is composed of a regular micrometer with its anvil cut off and the frame fixed into a base plate which, in turn, rests upon three hardened legs. Great care should be taken when milling the slots into the base plate to receive the frame of the micrometer, as it must stand perfectly perpendicular with the base to insure accuracy. Upon this base plate rests the plate *b*, which serves as the anvil of the micrometer. It should be hardened, ground, and lapped on its sides perfectly parallel and is held in position by the two screws, *cc*, which fit blind holes, so that the anvil surface will be free from any obstructions. The wires are shown in position at *eee*. It is not really necessary to have this fixture as an ordinary pair of micrometers may often answer—especially for measuring fine pitch screws—but it can be easily seen that the fixture makes the work very much easier to handle.

Table No. 1 has been computed by the writer for use in connection with this method of measuring threads. It gives the measurements that are obtained by using certain sizes of wires for the certain pitch threads, both V. and U. S. Standard. It not only gives the sizes for standard threads but for numerous others with their corresponding diameters. As an illustration of the use of these tables let us suppose that a 10 pitch, ⅝-inch V-thread tap is to be cut. Following down the first column (marked diameter of screw) we come to ⅝. The next column shows the threads per inch, which in this case is 10; the third column gives the distance from center to center of adjacent threads, or .1. The fourth column gives the diameter of the wire that is to be used and then, following on to the right, the next three columns are the properties of a V-thread, and the last four of the U. S. Standard thread, giving the diameter of core, flat on threads and also the diameter of the screw at its apex of the thread angles, or in other words, the diameter that would result if the flats were omitted and the sides ran to a point; see diameter *A* in the cut. The last column is the diameter measured over the wires. As the tap is a V-thread, the fourth column shows that a .07 wire is to be used and the seventh column gives the actual size that is to be measured over the wires; which in this case is .6618, Had our tap had U. S. S. threads the size of wire would have been the same but the over-wire measurement would have been .68344.

It may be desired to measure some thread that is not found in Table 1, and for this purpose reference is made to Table 2, which gives the constants used in connection with certain sized wires on 60-degree threads. This table covers nearly all threads used, and with it the diameter required for the measurement may be easily obtained. In the first column are the threads per inch, ranging from 2 to 100, and any intermediate thread measurement can be obtained. In the upper column, running horizontally from left to right, are the different diameters of wires that may be used and under the different sizes appear the constants in line with the pitches

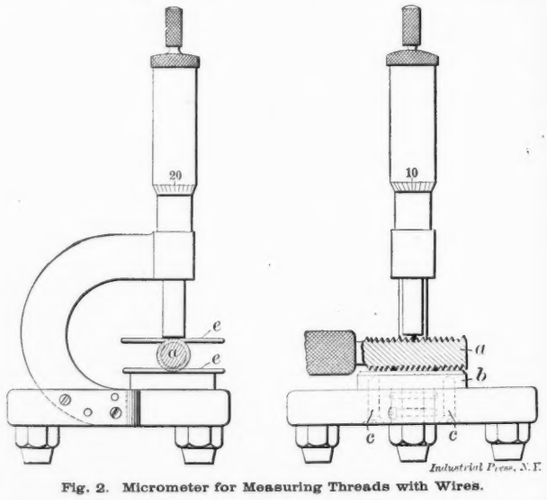


Fig. 2. Micrometer for Measuring Threads with Wires.

to which they apply. The rule for the use of this table is as follows: Divide the constant 1.732 by the pitch and this gives the double depth of the thread. Subtract this from the diameter of the screw, and to the remainder add the constant selected from the table, the result being the diameter that is to be measured over the wires. The constants in this table are equal to twice the distance from the root of a 60-degree V-thread to the top of its relative size wires, as will be seen in Fig. 3, in which *CC* represent the constant, *R* the root diameter and *D* the diameter of the screw.

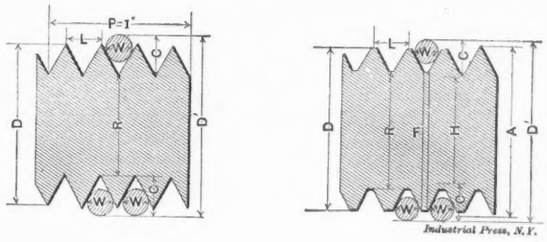
For example, we will suppose that a ⅝-inch, 10-thread tap is to be made by the use of Table No. 2. As diameters are not given in this table we look up 10 pitch, in the first column, and following this along to the right we come to the constant .180, and at the head of this column we note that this constant

is to be used with a wire .06 inch in diameter. If we have not this size at hand we can select from three other sizes, or in other words, a ten-pitch thread can be measured with either an .060, .070, .080 or .090 wire. Having an .080 wire at hand we select the constant for this wire which in this case is .240.

Following our rule we then have $\frac{1.732}{10}$ = .1732 and diameter of screw equals .625 — .1732 = .4518, which is the core diameter of the screw. Then .4518 + .240 = .6918, which is the size that is to be measured over the tops of the .080 wires.

The foregoing example was for a V-thread screw but the table may be used equally well for a U. S. S. thread, the only difference being that we must consider the threads of the screw continued up to an apex thus giving a larger diameter for a certain size of screw, as will be seen in column eight

TABLES FOR MEASURING V AND U. S. S. THREADS WITH THE AID OF STEEL WIRES.



D = Diam. of Screw.	P = Threads per inch.	L = Distance from Center to Center.	W = Diam. of Wire used.	V Threads. R = Diam. of Core.	V Threads. Double Depth of Thread.	V Threads. D¹ = Diam. over Wires.	U. S. Standard Threads. R = Diam. of Core.	U. S. Standard Threads. F = Flat on Threads.	U. S. Standard Threads. A = Diam. of Apex of 60° Angle.	U. S. Standard Threads. D¹ = Diam. over Wires.
1/4	18	.0555	.035	.1538	.0962	.2588	.1778	.00694	.2620	.2708
"	20	.0500	"	.1634	.0866	.2684	.1851	.00625	.2608	.2792
"	22	.0454	"	.1713	.0787	.2763	.1910	.00568	.2598	.2861
"	24	.0417	"	.1778	.0722	.2828	.1963	.00521	.2590	.2918
5/16	18	.0555	"	.2163	.0962	.3213	.2403	.00694	.3245	.3333
"	20	.0500	"	.2259	.0866	.3309	.2476	.00625	.3233	.3417
"	22	.0454	"	.2338	.0787	.3388	.2535	.00568	.3223	.3486
"	24	.0417	"	.2403	.0722	.3453	.2588	.00521	.3215	.3543
3/8	16	.0625	.040	.2667	.1083	.3867	.2938	.00781	.3885	.4002
"	18	.0555	"	.2788	.0962	.3988	.3029	.00694	.3870	.4108
"	20	.0500	"	.2884	.0866	.4084	.3101	.00625	.3858	.4192
7/16	14	.0714	.050	.3138	.1237	.4638	.3447	.00892	.4529	.4792
"	16	.0625	"	.3292	.1083	.4792	.3563	.00781	.4510	.4927
1/2	12	.0833	"	.3557	.1443	.5057	.3918	.01041	.5180	.5237
"	13	.0769	"	.3668	.1332	.5168	.4001	.00961	.5166	.5334
"	14	.0714	"	.3763	.1237	.5263	.4072	.00892	.5154	.5417
"	16	.0625	"	.3917	.1083	.5417	.4189	.00781	.5135	.5552
9/16	12	.0833	"	.4182	.1443	.5682	.4543	.01041	.5805	.5862
"	14	.0714	"	.4388	.1237	.5888	.4697	.00892	.5779	.6042
"	16	.0625	"	.4542	.1083	.6042	.4813	.00781	.5760	.6177
5/8	10	.1000	.070	.4518	.1732	.6618	.4951	.01250	.6466	.6834
"	11	.0909	"	.4676	.1574	.6776	.5069	.01136	.6447	.6973
"	12	.0833	"	.4807	.1443	.6907	.5168	.01041	.6430	.7087
11/16	10	.1000	"	.5143	.1732	.7243	.5576	.01250	.7091	.7459
"	11	.0909	"	.5301	.1574	.7401	.5694	.01136	.7072	.7598
"	12	.0833	"	.5432	.1443	.7532	.5793	.01041	.7055	.7712
3/4	10	.1000	"	.5768	.1732	.7868	.6201	.01250	.7716	.8084
"	11	.0909	"	.5926	.1574	.8026	.6319	.01136	.7697	.8223
"	12	.0833	"	.6057	.1443	.8157	.6418	.01041	.7680	.8337
13/16	9	.1111	"	.6201	.1921	.8301	.6682	.01389	.8366	.8542
"	10	.1000	"	.6393	.1732	.8493	.6826	.01250	.8341	.8709
"	11	.0909	"	.6551	.1574	.8651	.6944	.01136	.8322	.8848
7/8	8	.1250	.090	.6585	.2165	.9285	.7126	.01563	.9021	.9556
"	9	.1111	"	.6826	.1924	.9526	.7307	.01388	.8991	.9767
"	10	.1000	"	.7018	.1732	.9718	.7451	.01250	.8966	.9934
15/16	8	.1250	"	.7210	.2165	.9910	.7751	.01563	.9646	1.0181
"	9	.1111	"	.7451	.1924	1.0151	.7932	.01388	.9616	1.0392
1	8	.1250	"	.7835	.2165	1.0535	.8376	.01563	1.0271	1.0806
1	9	.1111	"	.8076	.1924	1.0776	.8557	.01388	1.0241	1.1017
1 1/8	7	.1429	"	.8776	.2474	1.1476	.9394	.01786	1.1559	1.1785
1 1/4	7	.1429	"	1.0026	.2474	1.2726	1.0644	.01786	1.2809	1.3035
1 3/8	6	.1666	.150	1.0863	.2887	1.5363	1.1585	.02083	1.4110	1.5723
1 1/2	6	.1666	"	1.2113	.2887	1.6613	1.2835	.02083	1.5360	1.6973
1 5/8	5 1/2	.1818	"	1.3101	.3149	1.7601	1.3888	.02273	1.6647	1.7998
1 3/4	5	.2000	"	1.4036	.3464	1.8536	1.4902	.02500	1.7933	1.8969
1 7/8	5	.2000	"	1.5286	.3464	1.9786	1.6152	.02500	1.9183	2.0219
2	4 1/2	.2222	"	1.6151	.3849	2.0651	1.7114	.02777	2.0481	2.1132
2 1/4	4 1/2	.2222	"	1.8651	.3849	2.3151	1.9614	.02777	2.2981	2.3632
2 1/2	4	.2500	"	2.0670	.4330	2.5170	2.1752	.03125	2.5541	2.5711
2 3/4	4	.2500	"	2.3170	.4330	2.7670	2.4252	.03125	2.8041	2.8211
3	3 1/2	.2857	.200	2.5052	.4948	3.1052	2.6288	.03571	3.0618	3.1670
3 1/4	3 1/2	.2857	"	2.7552	.4948	3.3552	2.8789	.03571	3.3118	3.4170
3 1/2	3 1/4	.3076	.250	2.9671	.5329	3.7171	3.1008	.03845	3.5666	3.7837
3 3/4	3	.3333	"	3.1727	.5773	3.9227	3.3170	.04167	3.8222	3.9949
4	3	.3333	"	3.4227	.5773	4.1727	3.5670	.04167	4.0722	4.2449
4 1/4	2 7/8	.3478	"	3.6476	.6024	4.3976	3.7982	.04347	4.3253	4.4729
4 1/2	2 3/4	.3636	"	3.8702	.6298	4.6202	4.0276	.04545	4.5787	4.6989
4 3/4	2 5/8	.3809	"	4.0902	.6598	4.8402	4.2552	.04761	4.8324	4.9226
5	2 1/2	.4000	"	4.3072	.6928	5.0572	4.4804	.05000	5.0866	5.1438
5 1/2	2 3/8	.4211	"	4.7708	.7292	5.5208	4.9531	.05263	5.5911	5.6119
5 3/4	2 3/8	.4211	"	5.0208	.7292	5.7708	4.2031	.05263	5.8411	5.8619
6	2 1/4	.4444	.300	5.2302	.7698	6.1302	5.4228	.05555	6.0962	6.2264

Table No. 1.

of Table 1. The diameter of a ⅝-inch 60-degree U. S. S. thread with the sides of the threads brought up to an apex would equal .6466. Then we proceed as with the V-thread, by taking this as the diameter and from it subtracting the double depth of the thread and adding the constant from the table. Thus: $\frac{1.732}{10} = .1732$ and $.6466 - .1732 = .4734$, which added to the constant for the .080 wire equals $.4734 + .240 = .7134$, which is the diameter which is to be measured over the tops of the wires for a U. S. S. thread.

Table No. 3 furnishes the data for measuring Acme standard screw threads of the pitches most commonly used on that style of thread. In the first column is given the number of threads per inch; in the second the double depth of the threads, by means of which the core diameter may be obtained; while the third column shows the size of wire that is to be used, which equals one-half the pitch, or nearly so. In the fourth column we find the amount that is to be added to the core diameter to find the measurement over the wires, and the last column gives the amount that is to be added to the largest diameter of the screw to obtain the same measurement. The convenience of this last column lies in its making it unnecessary to find the core diameter of the screw in order to measure the thread. For example: Should it be desired to cut a one-inch screw with six threads per inch, the only computation necessary would be to add the value found in the last column to the outside diameter of the screw, or $1.000 + .00898 = 1.00898$, which is the size that is to be measured over wires .083 inches in diameter for this size and pitch of Acme thread.

* * *

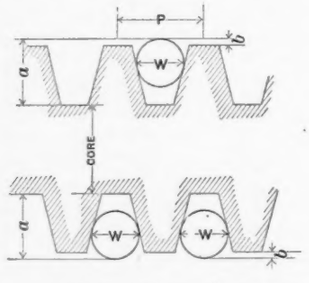
The nickel-steel alloy known as "invar," which has a coefficient of expansion of nearly zero (about 0.00000073 for 1 deg. F.) is being used to some extent by the United States Geodetic Survey in the construction of transits, but its use for measuring tapes is as yet made difficult by the fact that all nickel-steel alloys having a large percentage of nickel, are too soft to allow their use in the field for measuring purposes. It is hoped that this difficulty will soon be overcome, since promising results in that direction have been accomplished in France already. It is a consummation to be hoped for in the interests of exact measurements of base lines —the present method of using an iced bar, is very expensive and cumbersome.

TABLE OF CONSTANTS USED IN CONNECTION WITH WIRES FOR MEASURING THREAD DIAMETERS.

Threads per inch.	Diameters of Wire.																	
	.007	.010	.015	.020	.025	.033	.040	.050	.060	.070	.080	.090	.100	.150	.200	.250	.300	.350
2																	.9000	1.050
2½																	.9000	1.050
2⅝																.750	.9000	1.050
2¾																.750	.9000	1.050
2⅞																.750	.9000	1.050
2⅞																.750	.9000	1.050
2⅞																.750	.9000	
3															.600	.750	.9000	
3¼															.600	.750	.9000	
3½															.600	.750		
4														.450	.600			
4½														.450	.600			
5														.450				
5½														.450				
6													.300	.450				
7												.270	.300					
8											.210	.270	.300					
9										.210	.210	.270	.300					
10									.180	.210	.240	.270						
11									.180	.210	.240							
12								.150	.180	.210								
13								.150	.180									
14								.150										
16							.120	.150										
18							.120	.150										
20						.105	.120											
22						.105	.120											
24					.075	.105												
26					.075	.105												
28					.075													
30				.060	.075													
32				.060	.075													
36			.045	.060														
40			.045	.060														
48			.045															
56			.045															
64		.030																
80		.030																
100	.021																	

Table No. 2.

CONSTANTS FOR USE IN MEASURING ACME STANDARD 29 DEG. SCREW THREADS.



Threads per inch.	Double Depth of Thread.	Diameter of Wire used.	Diameter over Wires minus Core Diameter = 2 *a*.	Diameter over Wires minus Diameter of Screw = 2 *b*.
1	1.0200	.5000	1.0836	.0636
1½	.7700	.3750	.8178	.0478
2	.5200	.2500	.5520	.0320
3	.3533	.1660	.3746	.0214
4	.2700	.1250	.2860	.0160
5	.2200	.1000	.2330	.0130
6	.1866	.0830	.1966	.0100
7	.1628	.0710	.1700	.0072
8	.1450	.0625	.1535	.0085
9	.1310	.0550	.1360	.0050
10	.1200	.0500	.1266	.0066

Table No. 3.

TWENTY-FOURTH ANNUAL MEETING

OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of the American Society of Mechanical Engineers was held from December 1 to December 4, inclusive, and was characterized by an unusually large attendance. The opening session, at which the retiring president delivered the annual address, was held at the society house, which was crowded to its utmost capacity. The subsequent sessions were held at Mendelssohn Hall, New York City, and Stevens Institute of Technology, Hoboken, as the society's hall is entirely inadequate to accommodate the large number who attend the annual meetings. Social entertainment was well provided for. Besides the usual reception, one afternoon was devoted to an inspection of the immense power plants of the New York Edison Company, the Manhattan Railway Company and the Metropolitan Street Railway Company. On another afternoon Prof. Goldschmidt gave his interesting lecture upon "Alumino-Thermics," reviewed in these columns last month. The afternoon of the last day was utilized by an excursion to the works of the De Laval Steam Turbine Company, Trenton, N. J.

At the business session the report of the council was presented, covering the affairs of the society, and showing, among other things, that there was a net deficit for the year of over $1,100. In connection with this report Mr. C. W. Hunt made a statement concerning the Engineering Building project. He said that last year Mr. Carnegie attended a meeting of the Electrical Engineers and was much interested in the enthusiasm aroused by an address by Mr. Scott, the president, upon the necessity for co-operation of the different engineering societies. Finding the several great engineering societies of the country to be in good financial condition, with substantial resources, he suggested that they join forces and buy land, upon which he promised to erect a Union society house. The several organizations have since taken action upon Mr. Carnegie's proposed gift, and through funds advanced by Mr. Carnegie, have purchased a plot of ground on 59th Street, and it is now held, pending action by the several bodies.

The Mechanical Engineers have not only adopted resolutions favorable to the Union building, but have individually signed the resolutions, to emphasize the importance of the event. The Electrical Engineers and Engineers' Club have also fully adopted the scheme. The Mining Engineers, by their peculiar by-laws, were obliged to hold a letter vote, resulting in only 13 votes against the plan out of a total of 1,600 replies. The Civil Engineers were also unable to act immediately, but have had the gift under discussion and it will be voted upon in February.

To advance matters to a definite point an architect has made preliminary plans, which prove the plot of land ample for all requirements. But the estimated cost showed the million dollars to be given by Mr. Carnegie inadequate for so large a structure, and he was accordingly approached upon the subject and willingly agreed to furnish one and a quarter millions, or as much as might be necessary.

The next business was the report of the tellers to count the ballots on the amendments to the constitution and rules previously proposed, which were declared adopted.

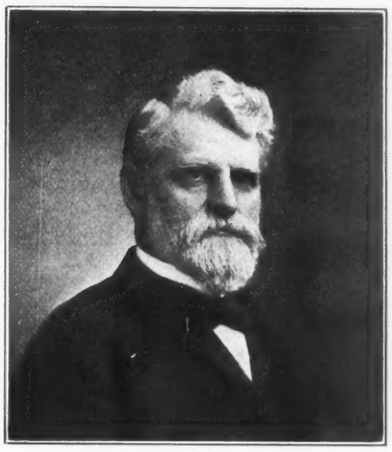
The President-elect then took the chair and in his brief remarks alluded to the formation of the society in 1880 and of a visit he then received from Prof. Sweet when the latter told him of the new society and its great advantages, and of its possibilities in the way of development.

Mr. Henry Harrison Suplee brought to the attention of the meeting the approaching twenty-fifth anniversary of the society and proposed that a historical record be prepared upon its organization, growth, books, pictures, relics, etc., and the president appointed Messrs. Suplee, Sweet and Hunt a committee for the purpose.

At the business meeting, also, the question of specifications for certain grades of steel was discussed, in view of the report of a committee appointed to confer with the American Society for Testing Materials. Mr. Henning, and Profs. Carpenter, Lanza and several others offered criticisms, chiefly against the proposal that the "yield point" be omitted from specifications.

The President for the Coming Year.

Ambrose Swasey, the newly elected president of the American Society of Mechanical Engineers, was born at Exeter, N. H., and spent his younger days in New England. His father and grandfather lived on the farm where he was raised and reached the venerable ages of 91 and 94 years, respectively. Mr. Swasey stills owns this farm and occasionally visits it in the summer time. At the age of 18 he left the old homestead and went to Hartford, Conn., to learn the machinist's trade at the Pratt & Whitney shops. He was accompanied by W. R. Warner, his boyhood chum, and now his business partner in the Warner & Swasey Company, Cleveland, O. While with Pratt & Whitney Mr. Swasey advanced to a



Ambrose Swasey.

position where he had much important work to do, particularly in the department of gearing. He developed, among other things, the machine used by this company for the production of true epicyclic curves and later his own generating and cutting machine, which is in use at the works at Cleveland. In 1880 the firm of Warner & Swasey was started, and while they have primarily been machine tool builders, they are better known to the public as builders of mountings and mechanism for astronomical instruments, particularly the telescopes at the Lick and Yerkes observatories and the naval observatory at Washington. Mr. Warner is a past president of the American Society of Mechanical Engineers, and it is highly complimentary to the firm that both its members have been able to honor the society by serving in this capacity.

The Professional Papers.

In the last number of MACHINERY was published a complete list of the titles of papers presented at the New York meeting, and from these we have selected several for review in this number. Brief abstracts of these, and of the discussions upon the papers, follow:

Tests have been made upon air motors and pneumatic hammers at the Aurora, Ill., laboratory of the C. B. and Q. R. R., and a paper by Max H. Wickhorst describes the apparatus used and gives the results of the tests. Those of the greatest interest relate to the power of a Vulcan pneumatic hammer, weighing 22 pounds, with a plunger weighing one pound and having an 8-inch stroke. The hammer was so placed that it would strike upward against a weight of 120 pounds, so connected with an autographic recording apparatus that any vertical movement of the weight was multiplied 8 times on the record. Tests were made with air pressures of 60, 80, 100 and 120 pounds and the distances the weight was raised by the hammer blows under the different pressures were, respectively, .004, .0052, .006 and .0065 feet. The corresponding foot-pounds per blow were accordingly, .48, .624, .72 and .7818. The strokes per minute were 834, 892, 964 and 1,000, and the horse power, found by multiplying the foot-pounds by blows

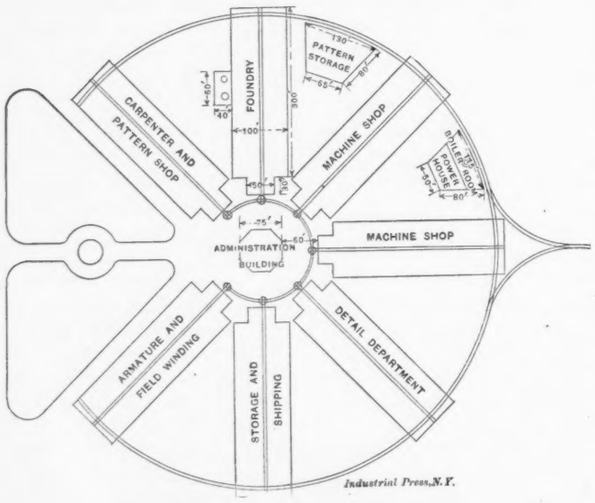
per minute, and dividing by 33,000 is, for the different air pressures, .0122, .0168, .021 and .0236.

The Construction and Efficiency of a Four-valve Engine, by Benj. T. Allen, related to a type of engine in which four Corliss valves are used for each cylinder, but are positively operated by a shaft governor. Engines of this class are usually operated at medium speed, not exceeding, say 200 revolutions per minute. The particular engine under description was built by the Harrisburg Foundry and Machine Company, and is tandem-compound, direct-connected to an electric generator. The cylinders are of the ratio 1 to 7.33, after the style advocated by Mr. Geo. I. Rockwood, high pressure cylinder 15 inches diameter, low pressure cylinder 40½ inches and stroke 27 inches. There is a reheating receiver between the cylinders. The engine runs condensing at 150 revolutions per minute. The boiler pressure varied during the tests from 90 to 153 pounds per square inch and tests were conducted with loads at 1-6, 5-8, 7-10, and 1 1-10 full load. The steam consumptions per I. H. P. per hour at these several loads were, respectively, 14.42, 13.59, 12.33, 12.66 and 12.73. These results indicate a remarkably small variation in steam consumption for different loads, representing a curve of economy closely approaching a straight line.

In the discussion Prof. Carpenter questioned the value of comparisons of tests where the boiler pressure changed so greatly. He also said that while the efficiency curve, found by plotting the total steam consumption in relation to the horse power, would become a straight line in the case of a throttling engine, which runs at fixed cut off, he had never known of an instance where it would be other than curved in the case of an automatic cut-off engine.

Mr. Rockwood, however, corroborated the "straight line" performance and said that in reality this engine, while actually an automatic engine, would throttle the steam at short cut-offs, tending to make the efficiency curve a straight line. He also testified to the excellent results with other "high-ratio compound" engines, and quoted tests giving results similar to the Harrisburg engine. The author of the paper said that as the steam was throttled in any case by the action of the valve at small loads, the low boiler pressure during certain of the tests introduced no error.

Suggestions for Shop Construction, by F. A. Scheffler, outlined the layout for a manufacturing plant, on the hub-and-spoke plan. In the center of the space available for buildings is located an administration building, constituting the business, accounting and sales offices; and on the second story,



Novel Arrangement of Manufacturing Plant.

the drafting room. This building is octagonal, or hexagonal, whichever may be found to be most suitable for the purpose. In this case, it has been designed with a view of accommodating seven buildings, which radiate from each side of the octagon, and has one side reserved for the main entrance through the building. The end of each shop which is nearest to the administration building has its individual office for the foremen and shop clerks.

The general arrangement gives each shop plenty of yard room, which is also very essential; and traveling cranes, either worked by hand or power, could be located in the yard room between any two of the shops, for handling raw or finished material.

A circular track around the administration building connected in front of each shop building by means of suitable turntables, worked by hand or power, makes the distribution of material between the buildings very easy, and it will be noticed that the distance the material will have to travel from any one building to another is comparatively short.

At the extreme outer end of each building is another circular track, primarily to be used for shipping purposes, and the distributing of such material as may come in or go out over the connecting railroad lines. This track runs through the end of each building; and in such buildings where the machinery, castings or other goods are to be handled, the heavier traveling crane in that particular building which should run the length of the shop, can easily unload or load the cars. This arrangement makes it possible to go into every shop without having a multiplicity of tracks and switches, thus cutting up the available yard room, as is usually the case in ordinary plants. It is also possible, if there is sufficient ground available, to extend any one or all of the buildings, and still retain the best features of the design.

In commenting on this construction, Mr. Suplee mentioned a penitentiary in Pennsylvania built on this plan, the guard house being at the center. A series of mirrors near the central portion of the guard house made it possible for an attendant sitting in a certain position to see what was transpiring in any of the radiating corridors without leaving his post or even changing his position.

"A compact Gas Engine, Beam Type," was the subject of a paper by C. H. Morgan. This engine is now being built and is designed in a way to minimize the lateral pressure of the piston on the cylinder walls. We shall not attempt to illustrate this engine at present, but there were several interesting points brought out in the discussion which will be referred to.

Prof. Sidney A. Reeve said there is a false impression that a blow is struck in a gas engine cylinder by the combustion of the gas. On the contrary, this is not so much the case as in the steam engine, considering the pressure at which the engine operates. In designing a steam engine for a steam pressure of 400 pounds per square inch, the pressure at which a gas engine works, there would be more trouble than in a gas engine, because with the former steam is admitted full pressure at the beginning of the stroke. He showed pressure diagrams, indicating the pressures sustained by the pins and bearings of gas and steam engines.

Mr. Thwait, the English engineer and gas engine expert, also corroborated this statement. Mr. E. A. Uehling presented data upon blast furnace gas. Above the requirements of the blast furnace and the heating of the blast there are 840 horse power per ton of iron produced available for outside purposes. In one plant 20,000 horse power answered requirements for blast furnaces, and there might be 18,000 horse power for sale in addition. While the amount of available power from different plants varies, in no case had he found it less than 800 horse power per ton of iron manufactured per hour. Though blast furnace gas is a lean gas, it is a very valuable gas for power purposes. When illuminating gas is used in a gas engine, there must be added 9 times the quantity of air while with blast furnace gas air need be added only about in the ratio of 1 to 1. In blast furnace gas there is only about 25 per cent. of combustible as against nearly 100 per cent. in illuminating gas; but when it comes to the final mixture of gas and air the illuminating gas will be found to have nearly 80 per cent. of nitrogen mixed with it and there will be more inert gas than with the blast furnace mixture. Besides the illuminating gas cannot be compressed to so high a pressure and is not so economical to use on this account.

In some respects the most important paper of the meetings was the report of a test by Prof. D. S. Jacobus upon a Rice and Sargent steam engine, using superheated steam. This is the first American-built engine of importance upon which tests have been conducted and reported before the society.

The high pressure cylinder of the engine has double-beat poppet valves and the low pressure cylinder, Corliss valves. The inlet and exhaust valves of each cylinder are operated by separate eccentrics. The inlet valves are closed by vacuum dash pots and the exhaust by a positive motion. A portion of the highly superheated steam furnished to the engine passes through a coil in the receiver between the high and low pressure cylinders. The cylinders are 16 and 28 by 42 inches. The steam is superheated in an independently-fired Schmidt superheater. With superheated steam the water consumption per horse power hour was 9.76 pounds at 474.5 horse power, 9.56 pounds at 420.4 horse power and 9.70 pounds at 276.8 horse power. The pressure of the steam at the engine throttle was slightly over 140 pounds per square inch, and the superheating from about 350 degrees to 400 degrees Fahr. The vacuum measured near the engine ranged from about 25 to 26 inches of mercury.

With saturated steam the water consumption was 13.84 pounds per hour per horse power at 406.7 horse power. In this test the vacuum was poorer than in any of the others, being 24.5 inches. It must also be borne in mind that the engine was built for superheated steam, and the cylinder ratio was not what would be used for saturated steam.

The coal consumption per hour per indicated horse power for superheated steam was 1.265 pounds at 475.5 horse power, 1.257 pounds at 420.4 horse power, and 1.288 pounds at 276.8 horse power. For the test with saturated steam the coal consumption was 1.497 pounds per hour at 406.7 horse power.

The coal consumption forms the most accurate basis for comparing the efficiencies of engines using saturated and superheated steam, because when the coal consumption is obtained it allows for any difference in the economy of the combined boiler and superheater from that of an ordinary boiler.

In the test with saturated steam the coal consumption was about 19 per cent. greater than that obtained at the same power with superheated steam. This does not form a proper basis of comparison, however for the two reasons already stated, which are that the engine was not built for saturated steam and that the vacuum in the test was not as high as it should have been. An engine of the same general type built for saturated steam, but of about twice the power, was tested by the author and the results were embodied in a paper presented by him at the Saratoga meeting. The vacuum in this case was exceptionally high, being over 28 inches. If the vacuum had been about 26 inches, as in the present tests, it is probable that the coal consumption on the basis already given would have been 1.42 pounds per hour per horse power. As the minimum coal consumption with superheated steam was 1.257 pounds per hour per horse power there is a gain in favor of using superheated steam of .163 pounds per hour per horse power, or the larger steam engine using saturated steam is about 13 per cent. less economical than the smaller one using superheated steam.

Mr. Rice, of the firm which built the engine, called attention to some of the details of construction. The poppet-valve seats are surrounded by live steam to avoid trouble from difference of expansion of valve and seat. The stuffing-boxes are on long necks, to remove them further from the heat of the steam. The valve-gear is of the Corliss type, but with independent linkage to give full closing and avoid slamming.

The cylinder ratio of this engine was the subject of some discussion. The ratio of high pressure to low pressure cylinder volume is about 3 to 1, which ratio was copied from European practice in superheated steam engines. Professor Jacobus stated that it might be found that lower cylinder ratios need to be used with superheated than with saturated steam, but that there is yet no definite knowledge on this matter.

"What are the New Machine Tools to be?" was the title of a paper by Prof. John E. Sweet, which we reprint in full. In the discussion, Mr. Howard P. Fairfield reported the results of work of students at Worcester Polytechnic Institute with high-speed steel. Tools of certain brands of this steel were given students to use in 14-inch and 16-inch lathes. They were told to first break down the tools, if possible, and then reduce the speed and feed until a desirable balance was reached. On diameters of about 2 inches the lathes were not able to make good. The trouble seemed to be confined entirely to the headstock and carriage and most of the trouble seemed to be due to lack of material in the headstock itself. At the diameters turned a high speed was needed to give the necessary surface speed. He finally put on a heavy faceplate of large diameter to prevent tearing the headstock to pieces. The faceplate absorbed much of the jar and vibration due to the heavy cut. Mr. Fairfield suggested that the engine lathe needs more material in its headstock, broad surfaces in its carriage, which should be nicely gibbed, a positive drive to its feed works, a less number of steps on its cone and wider belts, and a massive faceplate.

* * *

WHAT ARE THE NEW MACHINE TOOLS TO BE?

A. S. M. E. PAPER BY PROF. JOHN E. SWEET.

It is a fact quite apparent to users of machine tools (and first among them are the machine tool builders themselves) that the new high-speed tool steel calls for a redesigning of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers.

I expect the machine tool builders have already the reply formulated as follows: "You just keep on building engines and leave the machine tool business to us." But that will not quite do. If no one but the engine builders had mixed in the engine business, we would have had no turbine engines, and many of the standard machine tools were originally devised by those who had use for them, rather than by the man who devised things to sell.

I think the machine tool builders will admit that the machines must be redesigned; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say everything has been all right, and all we need to do is to change the strength and power. But have they been all right or half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross girt plan in any form, and yet in the case of lathes, the whole business of whose beds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost in patterns and foundry work, and so, too, the tables which are sprung by bolting down work can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry.

The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which, with the springing by bolting down the work, are the primary causes of cut ways.

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends when fastened to the housings. The most of them are three sides of a box only, or one-tenth the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands and then put the material so that it will be four times more rigid will be something like it. Housings of box section will be just as rigid fore and aft and much more rigid against side strain.

Milling machines of the planer style are constructed like

planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load overrunning the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the tabie, because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle, the pressure is always in the middle, first in one direction and then the other, exactly the reverse from the gravity action, and instead of the side guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and have to be refitted are never just right except when new and when so refitted. Where a short block slides on a long guide, if the scraper marks wear out sooner along the middle than at the ends, the ends of the guide need cutting off, however much overrun it gives to the sliding block.

The draftsman dare not make a drawing of an engine crosshead overrunning the guide one-third of its length at each end; the builder would hardly dare to build it if he did, and no user has the courage to take out the guides and cut them off or cut away the surface even when he knows it would be money in his pocket, but it is the thing to do. We find that in the case of a slipper guide, owing to the effect of inertia and momentum giving a twisting action to the crosshead, it is necessary to cut away the guide so that the crosshead will overrun very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the cross-heads overrunning that way and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders, which does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the results do not seem to justify the claim.

The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Sellers planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed round so as to properly mesh with a plain spur gear, or one with the teeth at such an angle as to skew the worm a little more, will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself. The value of lathes, particularly those used for face plate work, is considerably improved by having large and short main bearings. They should be large to resist torsion and short to resist bending, and the ordinary face plates are ridiculously frail. To get the best of a face plate it should be box section and as large as will swing in the lathe.

Owing to the rapid wear of screws the writer is convinced that a precision screw in any lathe used in manufacturing is of no special value over a fairly good one. Wearing the screw in one place while threading a few hundred pieces destroys the precision in a way which no future use will ever correct.

If the designer will analyze every detail he will find that many of the old features were not right to meet the old conditions and are not half right for the new.

While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which will do a variety of work will be still in demand, for the sparsely settled sections of the country and the colonies will call for the country machine shop as of old.

It is the hope of the writer that this tirade will bring out an interesting discussion on machine design and the capabilities of the high-speed steel, for that is the object of its presentation.

* * *

THE REID PROCESS FOR PRODUCING ELECTRICITY FROM FUEL.

There have been many types of apparatus devised for producing electricity direct from fuel, either by the thermo-electric process, such as by the use of the thermopile, or by an electrolytic process, in which some form of battery is employed. All have so far been commercial failures, but it will nevertheless be of interest to describe a new apparatus for this purpose, a demonstration of which was recently made at Newark, N. J., before a party of engineers and representatives of the press. The apparatus is the invention of Mr. James H. Reid, of Newark, and apparently the demonstration was successful; but not until a test has been made by expert and disinterested engineers, which Mr. Reid promises will be done in the near future, can any prediction be made as to the merits of the process. The following description is in accordance with the statement given us by the inventor.

The Reid process of generating electricity from fuel is electrolytic, the apparatus being essentially a gas battery in which hydrocarbon gas is oxidized. The oxidation takes place in an alkaline electrolyte between carbon and iron electrodes, and sets up an electromotive force of 9-10 volt per cell. The temperature of oxidation is low compared with that of a firebox, being only about 392 degrees F., and the action is comparatively slow. "Minute subdivision and slow oxidation" expresses a fundamental principle of the process. When the fuel is converted into a gaseous state it is, of course, minutely subdivided, and since the oxidation takes place at a low temperature, it takes place slowly.

When ordinary illuminating gas, containing, say, 650 B. T. U. per cubic foot, is used, it is diluted with about 40 parts of air to one part of gas, so as to always maintain an excess of oxygen. The mixture is forced through the electrolyte under a slight pressure, about 4 pounds per square inch being used for the demonstration. Since so poor a mixture is used it is at once apparent that producer or blast furnace gases can be used. All in fact are too rich and must be diluted with air for use. An evanescent gas like producer or blast-furnace gas is said to be better than the more stable illuminating gas. The electrolyte, as stated, is alkaline, being composed mainly of sodium hydrate (caustic soda), a small quantity of iron oxide, and a little calcium chloride to absorb moisture.

Referring to Figs. 1 and 2, which show end and side sectional views of an apparatus after which substantially the commercial machines will be patterned, *A* shows the lower part of the shell, and *B* the upper part. These parts are separated by insulation and form the positive and negative poles, the connection for the wires being shown at *A'* and *B'*. The lower part *A* forms a trough containing the alkaline electrolyte and the iron electrodes *I*, *I*, *I*, etc., and from *B* are suspended the carbon electrodes *C*, *C*, *C*, etc. The carbon electrodes are made in the form of hollow plates having porous walls through which the gas entering the holes in the tops, from the chamber *D*, may filter and mingle with the electrolyte. A top view of a carbon plate, showing the holes for entrance of gas, appears at *H*, and a bottom view at *G*. As the carbon and hydrogen of the gas combine with the oxygen of the electrolyte, the latter begins to froth or foam and rise

in the pipe *O*, from which it passes through the space *P*. (This portion of the cut is diagrammatic. The free air inlet *K*, and exhaust for uncombined gas *J*, are actually one, strange as it may seem. The interchange takes place through a diaphragm, *R*, *R'*, composed of alternate layers of canvas and iron wire cloth.) Here the electrolyte is said to take in some oxygen to replenish its exhausted supply. The most of the necessary oxygen is supplied with the gas, however. The iron oxide acts as an oxygen carrier in much the same manner as

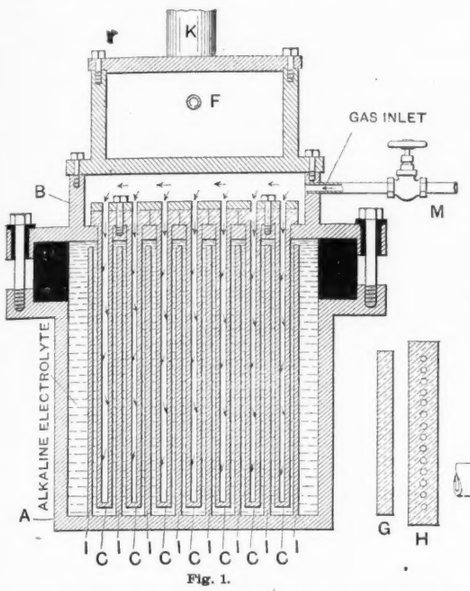


Fig. 1.

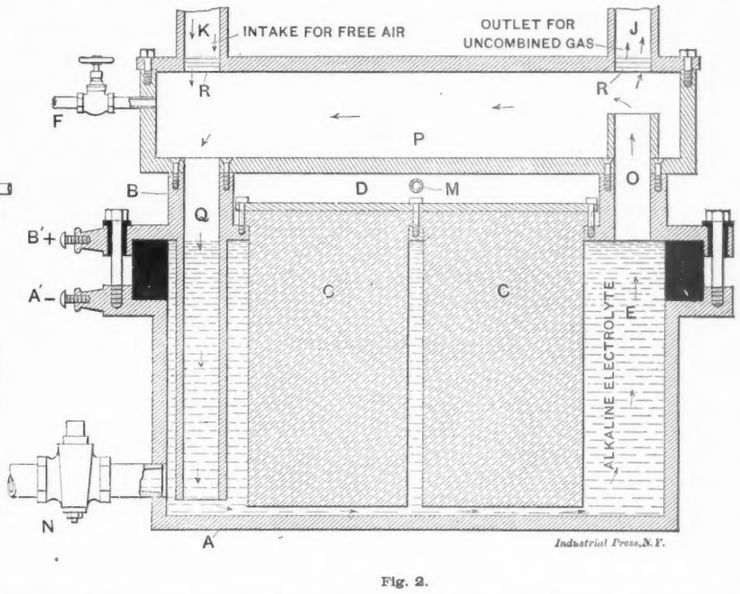


Fig. 2.

the red corpuscles of the blood. In fact Mr. Reid points out that his process is a mechanical parallel to that which takes place in animal bodies, i. e., carbon is oxidized at a low temperature in the lungs, the blood acting as an oxygen carrier. The chamber *P* and diaphragms in a measure correspond to the lungs, and the electrolyte to the blood. The circulation of the electrolyte is in the direction of the arrows, passing down through the pipe or passage *Q*. The gaseous products of oxidation and the unconsumed gas escape at *J*, but are not wasted in the commercial apparatus.

The pipe shown at *F* is primarily for admitting water to flush the apparatus when cleaning out; it is also used for admitting a small quantity of water when first starting it into operation, to take the place of that evaporated from the electrolyte by the application of external heat. The application of external heat has not yet been described. This is necessary to maintain the electrolyte at the proper temperature, viz.: 392 degrees F. The internal work or waste effort of a cell, even on short circuit, is by no means sufficient to maintain the required temperature. So in the commercial machines the gas retorts will be placed in close connection with the electric generating apparatus in order to use the radiated heat for this purpose. The gas retort is not shown in Figs. 1 and 2. When the machine is generating electricity, that is, when gas is admitted, the oxidation process forms CO_2 and H_2O, the latter being water in the form of steam, which helps to keep the balance of water required in the electrolyte, but water is added from time to time.

As already stated, the electromotive force generated is 9-10 volt per cell: to get 9 volts ten cells must be connected in series. From this it is apparent that, commercially, it will not be feasible to generate high voltages direct; but any voltage can, of course, be obtained with circuit breakers and static transformers in the case of alternating current; and rotary converters for direct current. The amperage depends upon the extent of carbon surface. One ampere is generated for each five square inches of carbon surface.

Two views of the experimental apparatus with which the demonstration was made are shown in Figs. 3 and 4. *A A'* are the generating cells; *B*, small gas generator; *C*, small steam boiler; *D*, air tank; *E*, voltmeter; *F*, ammeter; *G G'*, connecting wires or cables; *H*, one of four burners for each cell to warm the electrolyte; and *J J'*, diaphragms composed of alternate layers of iron wire cloth and canvas, to prevent escape of electrolyte and to allow the ingress of free air and the escape of waste gases. The cells, in this instance, are circular, and the carbon electrodes are round hollow rods, about 1½ inch diameter and 10 inches long, making the total carbon surface of each cell about 300 square inches. The carbons are each surrounded by an iron pipe electrode, perforated with holes. The space between the pipe and the carbon is about 3-16-inch all around. The cells were connected in series and developed a current of 1.8 volts and about 45 amperes,

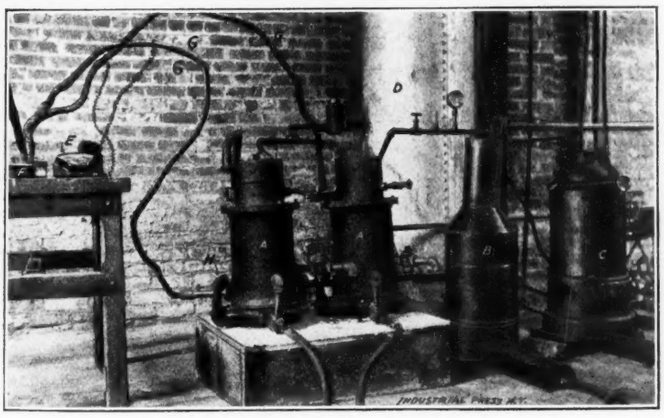


Fig. 3.

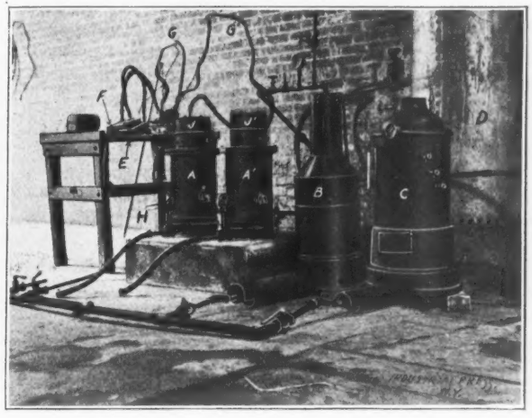


Fig. 4.

Experimental Electrolytic Apparatus for Producing Electric Power.

equivalent to about 1-10 electrical horse power. The gas connections are made at the bottom from the back. The pipe connections shown in front are for gas to maintain the temperature of the electrolyte, and terminate in four burners for each cell, one being indicated at *H*. In operation a casing covers the body of each cell so as to retain the heat.

It should be understood that the application of external heat in this manner is very wasteful, and that the gas used for the

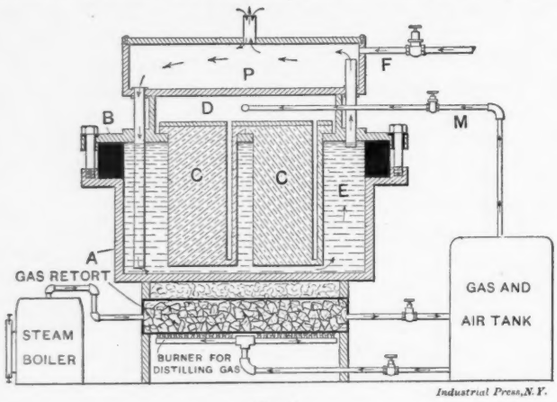


Fig. 5

purpose is not charged against the efficiency of the cells, but only that used within them. As already stated, the temperature of the electrolyte is maintained in the commercial machines by the heat radiated from the gas retorts. This is indicated in the diagram, Fig. 5. The consumption of gas per electrical horse power is said to be 5 cubic feet of 650 B. T. U. gas per hour, and the commercial efficiency as being over 45 per cent. of the total heat units in the coal.

* * *

WHY THE BUILT-IN MOTORS FAILED.

Editor MACHINERY:

On page 183 of the December number of MACHINERY an article from an exchange is commented upon editorially under the heading, "Hitching the Motor." It seems incredible that the author of this article should be so ignorant of the facts relating to the manufacture of electrical machines as to hold opinions such as are here expressed. Having designed most of the motors which are referred to as having been built in the headstocks of lathes, I have been in a position to watch their operation and would like to tell the real reason why they were superseded by standard motors geared to the lathes.

When the electrical firm referred to took up the matter of motor drive for machine tools, it received no co-operation at all from the tool builders, as the latter absolutely refused to make any change whatever in the design of their tools. In designing the first motors, therefore, it was simply a question of building a motor that would go into a rather limited space with a comparatively large hollow spindle through the center of the armature, to run at a certain speed and give the maximum horse power possible under these conditions. At that time the whole range of speed was obtained by the use of armature resistance and shunt field resistance. These first motors were failures, it must be admitted, but during the eight years that these motors have been in service, not one armature has had to be rewound on account of burn-outs, as stated. Some of them were rewound when the shop voltage was changed from 120 to 250 volts, but these motors served a most valuable purpose in demonstrating the utter impracticability of the use of armature resistance as a means of motor speed control when applied to machine tools. It was not until this same firm introduced the now well-known multiple voltage system into its own shop that a satisfactory method of controlling the speed of these motors was secured. But the real reason for discarding these old motors did not arise until about three years ago, when the introduction of new kinds of tool steel, allowing both higher cutting speeds and cuts of greater cross-section, necessitated the use of motors of larger capacity. As stated before, these motors had been squeezed into a certain given space, and by no possible means could they be made to run at the desired speed and give the torque required to remove the amount of metal that the new tool steels were capable of cutting off. It became a question of abandoning the motors or of using these lathes on a class of work for which they were not intended. The former plan was adopted and motors of ample capacity were attached to these lathes. That these motors should be of standard design was as natural as that a man when using a bolt should use one of standard dimensions; the advantages of using standard parts are as great in one case as in the other.

In order to show that the introduction of motor drive is not being retarded by the fear of "burnt-out" armatures, I would refer to the publishers of most of the large daily newspapers. The necessity of having no breakdowns in the printing press equipment when getting out the regular editions of a large daily is evident. The same firm that built the lathe motors referred to has built most of the newspaper press motors now in use in New York City, and of all of those installed I know of none that has burnt out.

It is true that electric motors often need repairing, but the primary cause of these repairs is almost invariably neglect. Other parts of the machine tool are constantly cleaned and oiled, but the motor is required to run with practically no attention and the dirt that accumulates sooner or later causes trouble. An electric motor, when properly used, is the equal of any other mechanical device now on the market, and, when one considers the amount of abuse it will stand, it surpasses most machines in durability as well as in satisfactory operation.

A. G. WESSLING.

While Mr. Wessling appears to take exceptions to our editorial comment, he substantially supports the dominant idea therein, viz.: "In the present state of the art it is bad design to make an electric motor an integral part of a machine tool." Why? Because such a motor is special; it costs more and cannot be readily replaced, since it is not of standard type. As our correspondent says, it is as natural that motors should be of standard design as that a man using a bolt should use one of standard dimensions.

Of the merits of the case in question, we know nothing, save what was learned casually, and in our comments in the last number did not intentionally, at least, lay the degree of stress upon the burning out of motor armatures that our correspondent seems to think; for it is of secondary importance whether a motor or its armature has to be replaced from this cause or from some other. But as a matter of fact, motors do burn out and must burn out when subjected to great overloads. While our correspondent informs us that the motors referred to did not actually burn out, it is safe to say they would have done so had it been attempted to make them carry the loads that the motors now in use have to carry.

We believe the best practice demands that the motor shall be so located that the whole motor, or any part of it, can be easily replaced by another of standard design, regardless of whether the change is necessary because of the advance in machine shop practice or because of repairs that are required from whatever cause. And we further believe that our correspondent agrees with us in this respect.—Editor.

* * *

The largest lifting machine in the world is said to be the 150-revolving jib crane at Howaldt's Works, Kiel, Germany. The height of the traveler rails from the ground is 154 feet 8 inches, and the length of the jib on which the traveler works is 146 feet 11 inches. A weight of 150 tons is lifted at the rate of 3 feet 3 inches per minute, and one of 15 tons at the rate of 31 feet 2 inches. The speed traveling along the jib is uniform, the rate being of 26 feet 3 inches per minute, and complete rotation of the jib is effected in 10 minutes. The traveler carries two capstans for winding up the steel wire lifting rope which are jointly driven by a 70 horse power alternating current motor. The wire rope is 2.36 inches diameter and is wound eight times around the lifting pulley. The rope for traversing the carriage or traveler has a thickness of 1.81 inches. Both its drum and the two capstan drums are rotated when traversing, but then the two capstan drums turn in opposite directions so that the height of the load is not altered.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Houille Blanche (white coal) Congress, which recently met in France, brought out some interesting facts regarding the possibilities of developing power from the mountain streams of the Alps and Pyrenees. It is said that the potential power of the waters formed by the melting of snow and ice in these mountain ranges is not less than 10,000,000 horse power, and that 500,000 horse power is already being utilized. France, as is well known, is a country practically destitute of extensive coal beds, and nearly all her coal has to be imported. It is estimated that the saving resulting from the utilization of mountain streams will be not less than $40,000,000 yearly. The economical development of mountain water power as found here is, of course, only made possible by the efficient long distance transmission by the high-tension alternating current.

A Jersey City firm has completed a "battery van" for the United States Government, which in reality is an automobile machine shop designed to go under its own power anywhere that a battery can go, and to be in readiness to make any repairs which may be necessary to the field guns. It has a speed of ten miles an hour and is supplied with two winches and a cable by means of which it can extricate itself from any morass or hole which it might be thrown into while in service. When loaded for the march it will weigh five tons. This will include four thousand pounds of miscellaneous equipment for the batteries which it is following. Six men can be accommodated on the vehicle. This outfit will be assigned to duty with one of the light field batteries and sent on a tour, during which all sorts of demands will be made on it and its conduct under all circumstances will be made the subject of a report.

INSURANCE OF MACHINERY AGAINST ACCIDENTS.

Stahl und Eisen, July 15, 1903, p. 850.

A prospectus has been issued by the *Stuttgarter Mit-und Ruckversicherungs-Aktiengesellschaft*, for the insurance of machinery against damages inflicted as the result of awkwardness or carelessness of the workman as well as from maliciousness. This insurance also proposes to cover such failures of material composing the machinery that may occur after the expiration of the builder's guarantee. Finally such insurance is to include not only the machinery of an establishment but also all that used for transmission purposes such as belting, wire, rope and cable, and, of course, hangers and shafting.

G. L. F.

COMPARATIVE COST OF GAS AND ELECTRIC POWER.

The *Scientific American* recently published the report of a very interesting test which was made in a printing establishment in New York City to determine the comparative cost of power obtained from gas engine and electric motor. The test was made with a 15-horse power gas engine and a 25-horse power electric motor, the average load carried being about 10 horse power. The comparison lasted over a period of two months, during which the gas engine alone was used, and two other months when the electric motor alone was in service. Gas was taken from the city illuminating mains at a cost of $1.05 per 1,000 cubic feet. The engine was run a total of 697 hours and the gas consumed cost $106.68, or an average of 15.3 cents per hour, which is about 1½ cents per horse power hour. Electric current was taken from the Edison mains, and the amount used during the 686 hours of operation of the motor cost $250.30, or an average of 36.5 cents per hour, which is about 3½ cents per horse power hour. Although this test certainly indicates a great advantage of the gas engine over the electric motor, the advocates of the gas engine should not be too sanguinary over the results, since it will be noticed that the motor was operated at but 40 per cent. of its rated capacity and consequently its efficiency was much below that which would have been obtained had it been run at full load.

ELECTRIC LOCOMOTIVES.

The New York Central Railroad has placed a contract with the General Electric Company for thirty electric locomotives to be built by that company in conjunction with the American Locomotive Company of Schenectady. It is said that the electric locomotives are to be of a new design and will weigh 85 tons each, of which 67 tons will be on the drivers. The rated power is 2,200 horse power each, and it is expected that the new locomotives will be capable of hauling a 500-ton train at the rate of 60 miles per hour. It is stated that the officials do not expect that the electric locomotives will show so great a saving of fuel as of maintenance. The fuel consumption of a steam locomotive running 60 miles per hour, is placed at 5 pounds of bituminous coal per horse power hour; with the electric motors, the losses of transmission will make it about 4 pounds at the axles. It is expected that at least 50 miles of each of the New York Central's branches out of New York, and of the New York, New Haven & Hartford Railroad will be operated electrically. The suburban trains will be operated by the multiple-unit system, each car having its own motors, but all under control of one motorman. The longer distance and heavier trains will be drawn by the electric locomotives. With the order for the locomotives, another was placed with the General Electric Company for eight four-stage, vertical Curtis turbo-generators of 7,500 horse power each for the power station.

In commenting on this *The Electrical World and Engineer* says: "It constitutes one of the most important events which have occurred in the history of electric traction since the equipment of the West End Railway, of Boston, in 1888 and 1899. That installation marked the confidence of the largest street railway company in the world at that time in what was then a new motive power. The contracts awarded by the New York Central & Hudson River Railroad, coupled with the adoption of electricity for its New York tunnel by the Pennsylvania Railroad Company, prove in an equally conclusive manner the confidence of steam railroad owners in what has been up to the present a comparatively untried motive power for heavy traffic conditions. The notable feature of the proposed New York Central installation is that electricity has been adopted not only for the tunnel section but as well for the service extending for a radius of about 50 miles on the main line and branches; in other words, for the entire suburban business."

HOW A LOCOMOTIVE WORKED ITS WAY ON THE OHIO RIVER.

Railway and Locomotive Engineering, December, 1903.

The story is told of the firm of Smith & Porter, which later became the well-known H. K. Porter Company. The original firm in 1868 built a locomotive for a small railroad running out of Greenup, Ky. This town is 333 miles below Pittsburg, Pa., on the Ohio River, and at about the time the delivery was to be made none of the towboats appear to have been available, the river being very low owing to a long drought, and other transportation facilities were not to be had. It was, however, decided by Smith & Porter that the engine should be delivered at the specified time. Mr. Smith obtained a suitable flat boat, and placed the machine aboard, and with the help of several men the locomotive was arranged to propel the boat.

The main driving wheels were at the rear, and the side-rod extended forward, as in many of our modern 4-4-2 engines. The front ends of the side-rods were uncoupled and the rods thrown back so that they extended out behind the engine as far as the leading wheels were ahead of the main drivers. The projecting ends of the side-rods were coupled to a temporary crank shaft, arranged for the purpose, and on the ends of this shaft were two paddle-wheels. The main drivers were jacked clear of the rail and the boiler was fired up.

In action the locomotive presented a strange appearance, standing on the deck of a scow, its leading drivers hanging motionless, its main driver slowly turning and its reversed side-rods working a crank shaft which made a pair of dripping paddles revolve, while the engine solemnly puffed its way down stream. This novel locomotive-steamboat made the voyage successfully, and furnishes a good example of what men of enterprise could do to overcome difficulties thirty-five years ago.

THE USE OF RIVETS INSTEAD OF BOLTS IN LOCOMOTIVE CONSTRUCTION.

Railway and Engineering Review, November 14, 1903.

The engine truck of a locomotive generally presents considerable opportunity for improvement both in design and in the matter of construction and repair. It is an axiom that with locomotives the nearer a construction approaches one single piece the more perfect it is. The length of wheel base on the present sizes of power has required the general use of a swinging center casting, which adds to the number of necessary separate parts. But contemplation of either a two or four-wheeled type will bring out in all cases several points wherein the construction could be somewhat simplified. The cradle or transom arrangement is often made in more separate parts than is necessary and in these days of steel castings a superior design of cradle in a particular case could, by the use of this metal, often be obtained. A consideration of the pedestal jaws in connection with the upper framing of the trucks reveals no adequate reason either of service, machinery or wheel changing work standing in the way of making these jaws integral with the frames themselves. Such integral construction would materially diminish the jarring which causes the binder bolts to always be loose. The use of bolts in other places than on these binders is unnecessary—rivets are certainly preferable, for the reaming of holes and machine fitting of the bolts are avoided and there are no nuts to work loose, while there is no occasion for removing such rivets except once a year in the back shop. In fact we know of lines where this plan has been standard for years and their roundhouse work books are not littered with requests to supply missing nuts to engine parts.

INDUCTION MOTOR FOR CRANES.

George L. Hoxie, in Journal Franklin Institute, November, 1903, p. 351.

The induction motor would probably not be used upon cranes and similar classes of work, except for the great desirability of polyphase motors for other work and the inconvenience of maintaining two separate systems of electrical supply. These considerations have, however, led to the use of the induction-crane motor in many cases. The motors, if of squirrel-cage construction, are built with high resistance end rings, and while they give, therefore, a large torque they are not very efficient machines. The efficiency of a direct-current machine is considerably the better through its entire range, and it has a wide range of operation over which its efficiency is quite good. An induction motor, on the other hand, reaches its maximum efficiency very abruptly.

Speed variation in a motor of this sort is accomplished by the use of a special compensator that provides varying impressed pressures. This is not an efficient means of regulation, since the torque of such a motor varies with the square of the impressed pressure. Crane motors with wound secondaries may be made to give a variable speed by the variation of a resistance in series with the secondary. This again is inefficient, though it provides a highly satisfactory torque curve. The motor is not so desirable mechanically since this method of control is considerably more complex. The motor with squirrel-cage secondary is probably the more desirable, on the whole, for this class of work.

RAISING WATER FROM DEEP WELLS BY COMPRESSED AIR.

Extract from Paper read by William H. Maxwell before the Bolton Meeting of the British Association of Waterworks Engineers.

The experiments carried out in the United States by Dr. Pohlé, of Arizona, who for some years past has been engaged in the application and development of the "air lift" system for raising water, oil and other liquids from underground sources, have proved that the main principle upon which the system operates is the following: Air under the necessary pressure, and of suitable volume, is admitted to the bottom of a pipe immersed in the water to be lifted in the manner shown in Fig. 1 of the sketch. By this means alternate bands or columns of air and water are formed in the water-pipe or "rising main," and the air does not, as might perhaps have been anticipated, pass through the mass of water. The result of this is that the aggregate weight of the water in the rising main is insufficient to balance the column of water in the boring, and the pressure of the latter therefore produces an upward movement of the air and water column in the rising main. As the force lifting this column is the head of water at *A* it follows that the height to which the water can be lifted depends upon the depth to which the pipe is immersed below the pumping level of the water in the boring; thus the higher the "lift" required the deeper must be the point at which the

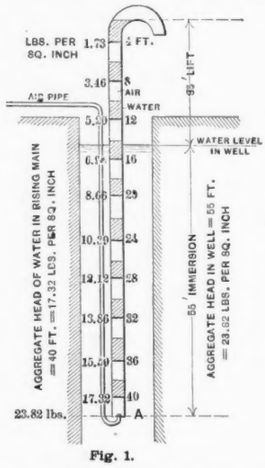


Fig. 1.

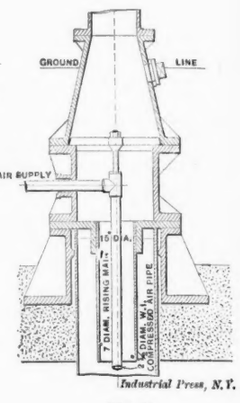


Fig. 2.

air is injected relatively to the normal water level therein, and so the height to which the water has to be raised determines the minimum depth to which the boring must be driven.

With regard to the best proportion between the immersion of the air nozzle and the "lift" of the water, opinions vary, but the author found that in his case the most economical result was obtained when the ratio was 3 (of immersion) to 1 (of lift) at the start, and 2.2 to one at the finish of the test. Under these conditions the efficiency worked out at 36.8 per cent. calculated from the steam diagram, and at 46 per cent. calculated from the compressor diagram, the volumes of air used and water lifted being in the proportion of 2.69 of the former to 1 of the latter.

From the results of his own tests and those of others, the author prepared the following, showing the approximate horse power required to compress one cubic foot of free air to different pressures per square inch:

	Pressure per sq. in.	H. P. per cu. ft. Free Air.
1. Solvay Works, Saaralben	176	0.434
2. Brostowe Estate, near Friedheim	140	0.376
3. Tunbridge Bridge Waterworks..	100	0.201
4. Tunbridge Bridge Waterworks..	80	0.189
5. Tunbridge Bridge Waterworks..	60	0.159
6. Sugar Factory, Glogan.....	45	0.145
7. Yard Works, Zwickan.....	30	0.121

With regard to the quantity of air required to lift a given volume of water to any specified height, the author found the following formula to give results in accordance with his own experience:

x = cubic feet of free air per minute;
A = gallons of water required per minute;
B = "lift" of water in feet;

$$x = \frac{A \times B}{125}$$

From this formula it is, of course, a simple matter to ascertain the quantity of water that can be lifted to any given height by a given quantity of air. The diameter of the air

pipe should be such that the velocity of the escaping air shall not exceed 20 feet per second. In a boring 350 feet deep, with the rest level of the water 96 feet below the surface and the pumping level 120 feet from the surface, with a discharge of 32,000 gallons per hour, an air pressure of 91 pounds per square inch was used. The rising main was 7 inches diameter and the air pipe was 2½ inches diameter. See Fig. 2.

EMERY WHEEL PRACTICE IN FOUNDRIES.

Extract from Paper read by Mr. Charles G. Smith before the Pittsburg Foundrymen's Association.

In iron foundry work there can be very little grinding done with economy on heavy castings, unless the iron is hard, in which case the swing frame machine with about 20 x 2½ inch wheel, running at 1,200 revolutions per minute, will grind considerably faster than it can be chipped. The amount of gain in grinding will, of course, depend on the hardness and ductility of the iron. I have seen castings so hard that it took two men one and three quarter hours to chip the gate and fin from one side. In such cases as this two men could have ground this gate and fin with a swing frame machine in a very little over fifteen minutes. But on soft iron the advantage is in favor of the chipping, as in this case the iron spalls before the chisel, and a man with one blow of the hammer can remove considerable of the gate and fin, which gives a great advantage in favor of the chipping. In a great many foundries I have noticed that the grinding on light castings has been done on light machines, using small wheels, and in almost every case the machine has been set without any regard to its stability.

The user will invariably be reimbursed if, in buying an emery grinding machine, he purchases a heavy stand with long bearings and large diameter of spindle, and places it on a concrete foundation. The machine will vibrate less than if it was standing on the floor. The wheels will become out of true less quickly than if they were set so that there may be vibration in the spindle. This will cause considerably less dressing of the wheel, and as it is always necessary to dress the wheel to the lower point when it has become out of true, the user will receive more than reasonable interest on the investment in the foundation in the amount of emery that is saved in truing the wheel. Then it is often the case that wheels too small have been used to accomplish satisfactory results. The largest diameter wheel practicable should always be used for doing any kind of grinding. For instance, a wheel 24 inches in diameter will do more work per dollar invested down to 18 inches in diameter than an 18-inch wheel will do. Another point to be regarded is the belt power furnished to drive the wheel. It is very necessary that the machine have belt capacity to keep the wheels up to speed while they are under duty, as the speed of a wheel when running idle will have no effect on the work if it is not kept up to this speed when it is doing the work. Neglect in the above-mentioned points has caused many to abandon the practice of grinding their castings with emery wheels.

For grinding any castings in a foundry where the man can lift the casting up to the machine it will be found that the most economical and satisfactory results can be obtained by having a heavy machine with 24 x 3-inch wheel driven with 5-inch belt, the wheel speeded at 1,000 revolutions per minute. This gives wheels heavy enough to resist the pressure of the work forced against them, and the power transmitted by the belt will force the wheels to cut instead of shrinking from duty and becoming out of true. This condition invariably occurs where the belt power is insufficient, and the man forcing the work with uneven pressure will bring the wheel to slacken its speed at intervals.

In steel foundry practice the emery wheel has been found to be quite a success, and is as far ahead of any other method that is commonly in use to a large scale on both heavy and light work, as is the case in malleable iron foundries. I have seen a gate ground with an emery wheel on a swing frame grinder by two men in less than 15 minutes. This same gate would have required about two and a half hours to remove on the planer or shaper.

MARINE TURBINES.

Journal of the American Society of Naval Engineers, November, 1903, p. 1241.

The following is an abstract of a report of a board appointed by the Navy Department to investigate the performance of the Steamer *Revolution*, which is equipped with Curtis steam turbines, and was built for experimental purposes. In view of the fact that turbines are now being considered by the Navy Department for use on naval vessels, and are about to be adopted for two Atlantic liners, the report is of timely interest.

The turbines are of the Curtis two-stage, compound, marine type, reversible and condensing. They are two in number, directly connected to the thrust and propeller shafting, each set of turbines driving one screw of about 4 feet 6 inches in diameter and 3 feet 4 inches pitch.

Aside from the ordinary advantages claimed for the steam turbine, the most noticeable feature observed was the almost entire absence of vibration or disturbing noises usually attending the running of fast-moving reciprocating engines, and the slight care and attention needed while in operation. These turbine engines were easily started, stopped and reversed, the time required for each operation being only that necessary for the opening and closing of a set of valves connecting the turbine casings with the main steam pipes. Five seconds was the maximum time consumed for the operation of reversing the motors from full speed ahead to full speed back, with two men handling the gear, one to each turbine. This may, however, be done by one man at a slightly increased expenditure of time. Various runs with corresponding stopping, backing and turning of the ship, were made at different speeds of rotation, the maximum speed of engines being about 650 R. P. M., and the minimum about 250. At full speed ahead the vessel turned readily either to starboard or to port in about thrice her length. Dead in the water, and starting one propeller full speed ahead and the other full speed astern, the vessel turned in her own length. Dead in the water, and with the helm hard to starboard, and then going ahead on the port propeller, the vessel turned readily to port, due to the action of the propeller race upon the rudder. Under these latter conditions it was noticed, however, that the vessel ceased to turn when the wind was well on the port beam.

Running full speed ahead with both screws, and then suddenly reversing the engines, the ship was brought to a standstill in about 32 seconds; the same conditions with one screw, required about 38 seconds. Similar operations were repeated with the vessel running at lower speeds, and about the same amount of time for reversing was required.

In a report on these turbines by Prof. Jas. E. Denton it is stated that at 672 R. P. M. an equivalent power of about 1,800 I. H. P. was developed by both turbines at a steam consumption equal to 18.14 pounds per equivalent I. H. P. This is, however, believed to be excessive, owing to the use of the steam in two stages only. With four-stage turbines the consumption of steam per I. H. P. should be reduced well within the margin of prevailing averages for marine engines.

The clearance spaces between the stationary and running blades on the revolving drum being made extremely small (from .02 inch to .06 inch), the amount of which is ascertained by a small, simple, micrometer attachment, and there being no flexible coupling arranged for between the turbine shaft and the thrust shaft, the bearing of the latter was provided with a handwheel mechanism actuating a yoke, so arranged as to maintain the original clearances by sliding the thrust-block on its sole plate, propeller, shafting and turbine drum all moving together. The wear on the thrust-block being very slight, this adjustment is only rarely resorted to.

The turbine shaft bearings, one at each end of the casing, run in oil, which is continuously circulated and cooled by water coils connected with the oil pump, no water circulation being used direct on the journals; water circulation is, however, used in the thrust bearing. The exhaust from each turbine issues from the casing of the upper half of the secondary stage through a 20-inch pipe into the condenser.

The main turbines consist principally of the casings, nozzles and revolving drums containing the bucket wheels and shafts. The steam enters at a pressure of 250 pounds through four steam nozzles, each of which supplies one-fourth of the full power of the turbine, and acts consecutively upon a series of bucket wheels constituting the "first stage," in which the steam expands down from 265 pounds absolute to about 16 pounds absolute. It then flows through four other nozzles, to act upon another set of bucket wheels, which form the "second stage," and there expands from 16 pounds absolute to less than 1 pound absolute, with condenser vacuum of 28 inches, the work done by the steam upon the buckets being thereby nearly equalized.

Reversing is made possible in a very simple manner by placing vanes on the outer rim pointing oppositely to the ahead buckets, all enclosed in the casing of the secondary stage. A separate steam pipe leads to this part of the casing and the steam is admitted by a separate valve.

The general ease with which the machines in question are cared for and handled is undoubtedly due to the great simplicity of the mechanism when compared with the reciprocating engine. As an engine it requires but little previous "warming up;" no cylinder drains to be opened nor any general filling up of oil boxes, sight feeds and wick cups, the turning on or the shutting off of the main steam supply being the principal and almost the only operation remaining. It might be here incidentally mentioned that the above points are not features peculiar only to the turbines of which this report treats, but hold in common for steam turbine machinery of the various designs and makes. The space occupied, judged in the light of a casual observation, is no less, but rather more, than that required by engines of the torpedo-boat class; but, as there is not the same amount of overhauling necessary, the extra space can well be spared. The weights of the turbines proper in this case are alleged to be 8¾ pounds per equivalent I. H. P., and are thus less than those of torpedo-boat engines, which run about 11½ pounds per I. H. P. The attention required and the amount of oil used are extremely small, owing to the entire absence of any internal or external oiling except the main bearings, which are automatically oiled. No frequent adjustments are required, as there are no rubbing surfaces, which may best be illustrated by the fact that the turbines in question have never been apart since first put up, covering a period equal to one and one-half years.

The points in conjecture with regard to these machines being their efficiency and their capacity to compete in economy with the best marine engines, should be ascertained by more accurate tests, both on land and on board ship, where this is possible.

Additional fore-and-aft space will be required for any efficient installation of turbines as compared with the reciprocating engine installation, and particularly will this be found in torpedo boats. This fact should be well recognized and be given due consideration, so that all parts of the mechanism, but particularly the condenser and other auxiliaries, may be installed in such manner as will permit frequent and necessary overhauling from the engine room.

As the turbine is more dependent upon a high vacuum than is the case with a reciprocating engine, it is essential that the main condensers and main air pumps must be favorably placed in the ship for ready examination and overhauling.

RESPONSIBILITIES OF INVENTORS.

E. P. Thompson in Stevens Indicator, October, 1903, p. 411.

How unfortunate for inventors, manufacturers, and other owners of patent rights, including corporations of enormous capital, that the value of a patent does not necessarily depend alone upon the value of an invention, nor upon any power that the inventor or other owner is supposed to possess. The inventor might be literary, a great scientist, an engineer, and an electrical expert, and might be able to explain an invention that he had made better than anybody else; and yet, if the description were not according to form, and especially if the solicitor should not have sufficient skill to word the claims to properly protect the invention, the invention would practically be given to the public.

My object is to show the principle underlying the difference between a properly broad claim and a narrow one, so that an inventor, in writing a description of the invention for his solicitor, may define his invention after the manner of a sufficiently broad claim. Electrical inventors are, in the present age, highly educated and should be perfectly competent to define their invention from a broad standpoint, and then the solicitor can improve the wording and form, and supplement applicant's claims by subordinate and perhaps by a slightly broader claim. I do not propose to take your valuable space by a lecture on the general principles of claims, but to show this one point by examples, by studying which, your readers will be competent to see that their claims are about what they should be.

Their inclination is to leave all to the solicitor, but this is not advisable, because however expert he is he is not infallible. As the whole value of the patent depends upon the scope of the claim, and as the inventor is the one who is best acquainted with the device and with the department of art to which the invention belongs, he must not leave the matter entirely to the solicitor; and the solicitor who refuses aid and suggestions from his client is more concerned with his own conceit than with his client's interests. The attorney is superior on all formal matters, but the client is superior on the merits. The solicitor should acquire as much as possible of the technical points, and the client should have a fundamental knowledge of the nature of claims.

A few examples will suffice to explain.

A few years ago there was an inventor who was the first to invent a new rheostat element adapted to be varied. His claim on this feature reads:

"The combination, with a box or case, of a pile of thin sheet-metal resistance plates therein, and a screw for regulating the pressure upon said plates, substantially as specified."

An inventor should not only make the invention in one form, but think of several ways of carrying out the device, and then formulate a definition to cover all the devices. All such devices could, I think, be covered by a claim reading:

"A variable electric resistance, consisting of the combination of a pile of electrical resistance plates, and means for varying the pressure upon said plates."

It is held that it would be easy for pirates to get around the patent claim, but difficult to avoid infringement of the proposed substitute claim, which may be possible of still further improvement.

Another case is that of a photometer for measuring mean spherical candle-power. The method consists in revolving two mirrors about an axis passing through the source of light under such conditions that the light from the source is reflected in different successive angles of a single plane upon the screen of a photometer, and also transmitted in this reflected passage according to a certain simple harmonic law. For our purpose, it is immaterial to explain what law this is, as too much space would be necessary. The broadest combination claim reads:

"In an apparatus for measuring the mean spherical luminous intensity of a source of light, the combination of two revolving mirrors, and means for varying the intensity transmitted to the photometer according to a simple harmonic law."

Why limit the protection to mirrors, leaving a loophole for another inventor to use refraction? Why confine the scope to a simple harmonic law, when the inventors are entitled to broad protection upon any arrangement of reflecting or refracting devices for securing the same result?

The claim could have been as broad as the following:

"In an apparatus for measuring the mean spherical luminous intensity of a source of light, the combination of a photometer, and revolvable devices so disposed as to illuminate said photometer proportionally to the mean spherical candle-power of said source."

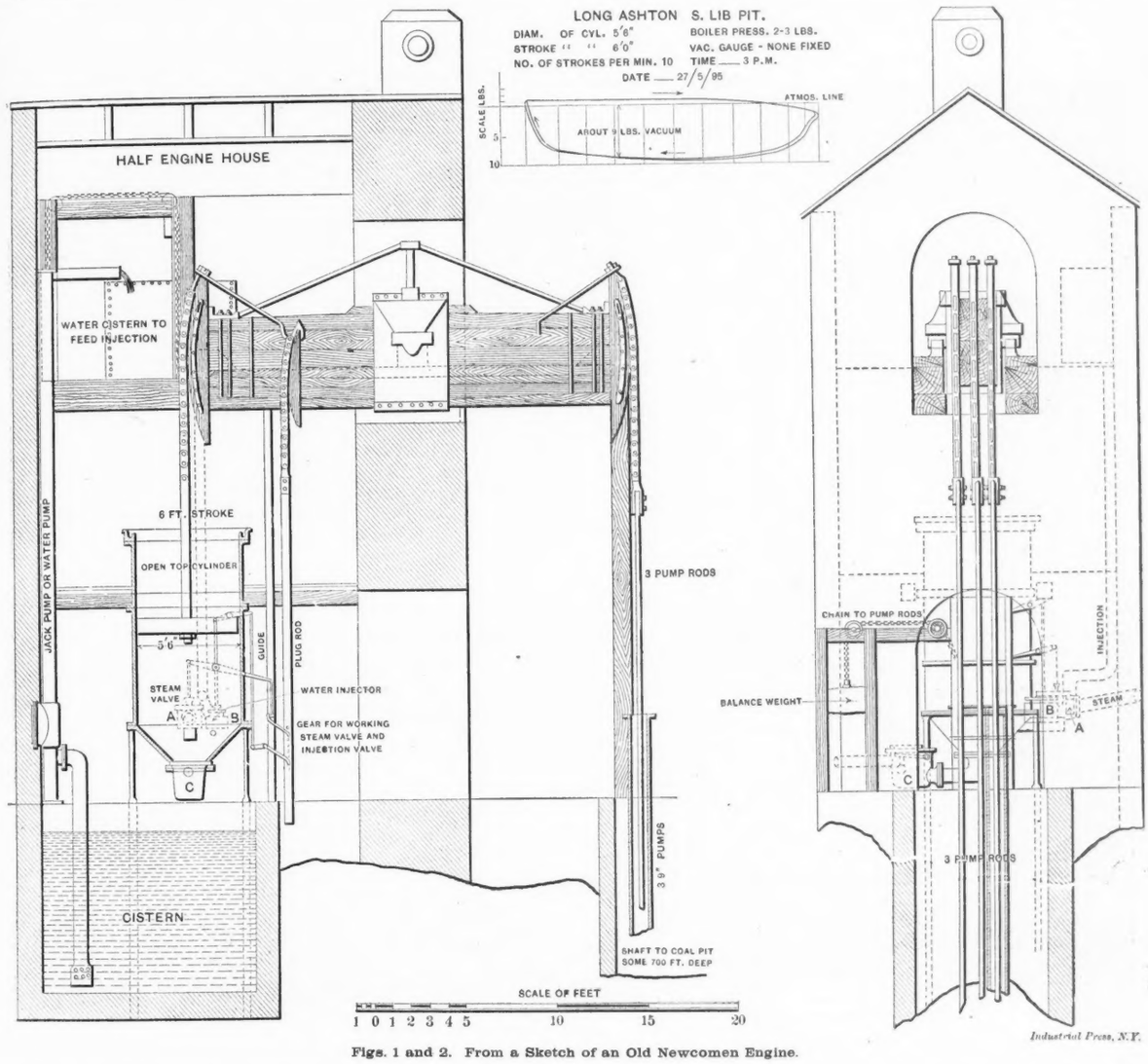
This claim would have protected the invention, whether on the principle of a simple harmonic law, or some other law. The patent claim is also faulty in the narrow term "two revolving mirrors." Other means could easily be invented,

and infringement avoided. If the scope is not defined by a proper wording of the claim, the patent is about as valuable as a house standing on a lot having a defective title.

NEWCOMEN ENGINE AT THE ASHTON VALE IRON WORKS*

From Paper read by Mr. Henry Davey before the Institute of Mechanical Engineers, October 16, 1903.

The earliest instance of a pumping engine for colliery purposes, which had come under the writer's notice, was that of the Newcomen engine at the South Liberty Colliery of the Ashton Vale Iron Company, near Bristol. As is well known, Thomas Newcomen, of Devonshire, invented, in 1705, the first successful cylinder and piston engines, and this example is considered one of the early large engines built by him, possibly about the year 1746-50.† The drawing, Figs. 1 and 2, shows the general arrangement of the engine, and has been prepared from a sketch the writer had made in September, 1895, when he had occasion to take some particulars on the spot for illustrating this old relic. The drawing, together with three photographs, Figs, 3, 4 and 5, will convey to readers the rude though successful working structure of Newcomen's age, with its trussed oak beam with circular ends and open-topped cylinder. The cylinder was 5 feet 6 inches in diameter, and had clearance enough to allow of working 8 foot stroke if required (the cylinder is 10 feet long). The piston was packed with rope ends and loaded with pig iron to help balance the indoor stroke, and was worked with a covering of water on the top, so that if the packing was not quite tight, water only passed through and helped to maintain the vacuum. The valves fitted to the cylinders consisted of a circular lift steam-valve for admission of steam (marked *A* in drawing), a slide-valve, *B*, for admitting injection water to condense the steam for forming the vacuum, and a flap-valve, *C*, kept closed by a weighted lever) for the escape of the condensed water. The Newcomen engine was utterly dependent on manually-worked valves, until that eminent youth Humphrey Potter devised self-acting catches, whereby the working beam was made to supplement the opening and closing of the valve.‡ This led to the introduction of the plug-frame fitted with catches to act on the valve levers—first put on a Newcomen engine by Henry Beighton in 1718. The engine was at first supplied with steam from a haystack boiler, but was latterly supplied with steam from the boilers working the winding engine, which was passed through a reducing valve into a receiver down to a pressure of 2½ pounds to the square inch, at which pressure it entered the cylinder. The beam was built of oak timber, trussed with rods 24 feet long and 4 feet deep, and had V-shaped gudgeons of cast-iron (bolted to the beam



Figs. 1 and 2. From a Sketch of an Old Newcomen Engine.

* Compiled by the writer from particulars taken by him from the engine itself at the South Liberty Colliery in 1895, at which date the engine was in regular work. It has since been dismantled. There is at South Kensington a photograph of this engine, taken many years ago, when it was in a more perfect condition than it was in 1895.

† Mr. W. G. Norris writes that he has little doubt that the castings for this engine were made at Coalbrookdale, about the year 1760, or perhaps a few years earlier; no castings so large could have been obtained much earlier than this date.

‡ Mr. Davey discredits the story of the Humphrey-Potter invention. The contrivance said to have been invented by Potter is described in the following: "In some engines there is a catch held by a chain fixed to the great beam, and this catch holds the eff from falling back and opening the cold-water cock, till the rising of the beam pulls the catch up by the chain and then the eff falls." The story probably arose from calling cock-buoy cock-boy, a buoy being used for opening and closing the cocks.

in the form of a collar) rocking in cast-iron gudgeon-blocks. Its weight with the gudgeons, trusses, etc., was about 5 tons. The engine made from ten to eleven motor strokes per minute.

The pumps, which were three in number, were bucket lifts, and 9¾ inches in diameter, and were worked from the end of the beam by chains secured to the beam and passing over the wooden arcs at ends of beam (as shown on the drawing) and thence down to the rods of pumps, which were of wood bolted together, with side straps. The pumps were in three lifts, and delivered one into the other from the bottom of the shaft, which was 750 feet deep. There was a jack-pump attached to the engine, which lifted water into a cistern at the level of the beam floor, to supply the injection water to the cylinder. It may, perhaps, be interesting to describe its mode of action. A vacuum was formed on the under side of the piston by the admission of steam, which was then condensed by the admission of the injection water, and the top of cylinder being open to the atmosphere, the atmospheric pressure exerted itself on top of piston, causing it to descend with an energy due to the perfection of the vacuum formed, and so producing the indoor stroke which lifted the pump rods at the other end of the beam, thereby actuating the buckets of pumps and lifting the water from the bottom of the shaft. The outdoor, or descending stroke, of the pumps was made chiefly by the weights of the rods, etc., and thus the double stroke was completed.

No indicator diagrams had ever been taken from the cylinder until the writer took some in 1895, for which purpose the cylinder had to be drilled and indicator connections and gear fitted. The diagram, shown with Figs. 1 and 2, represents the indicator cards showing the amount of vacuum to be between 9 pounds and 10 pounds. This diagram, at a speed of 10 strokes per minute, gives about 52 horse power. The old man, seen in Fig. 3, near the gudgeon-blocks, worked the engine up to the time of its being dismounted in 1900, and had driven it since he was a boy; his father and grandfather had worked the engine before him.

* * *

The property of calcium carbide of rapidly developing acetylene gas, when brought in contact with water, has led to its use as a means for raising and sinking submarine boats. The boat is supplied with an ordinary gas generator and a water tank, whose contents serve as ballast. The upper part of the tank is connected with the gas reservoir of the generator by a pipe so that gas can escape into the tank. The tank and the generator have pipes at the bottom opening into the sea water. The upper parts have vertical pipes for the escape of the gas. If the reservoirs are filled with water, the boat sinks.

After the introduction of a carbide cartridge into the gas generator gas is formed at once, which forces the water through the lower pipe into the sea. After opening the cock in the connecting pipe, the gas enters the tank and fills it by forcing out the water. The boat now rises to the surface, remaining there until the gas is allowed to escape from both reservoirs, which causes them to be again filled by sea water. If the boat has sunk deeper than desired, the introduction of a sufficiently large carbide cartridge into the generator will make the boat rise to the proper level. The apparatus is quite simple and works reliably, doing away with air and water pumps.

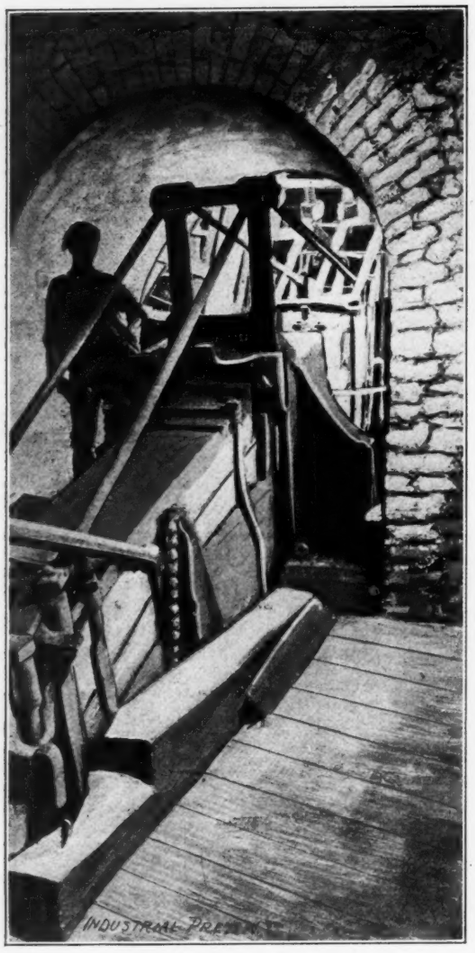


Fig. 3. View of Old Walking Beam.

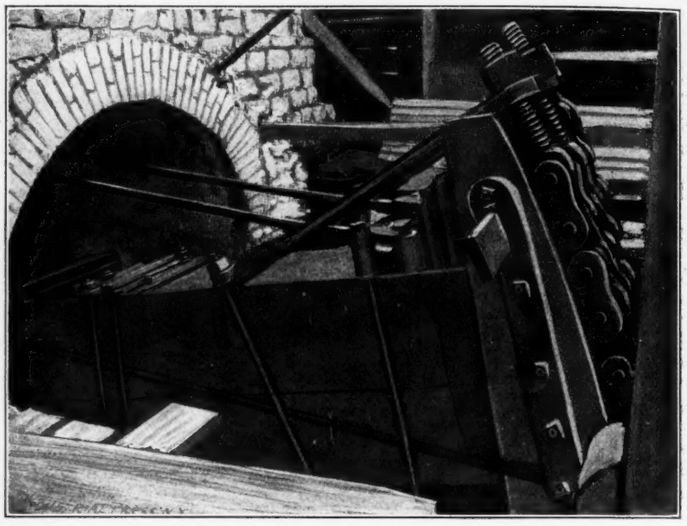


Fig. 4. Point of Attachment of Chains to Walking Beam.

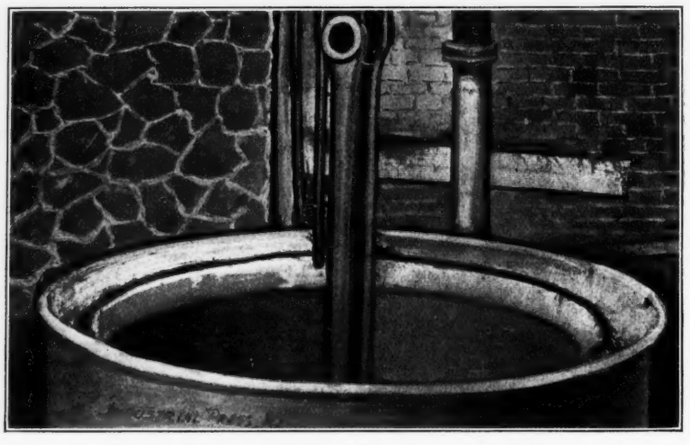


Fig. 5. View of the Open-top Atmospheric Cylinder.

TOOL MAKING.—2.

REAMERS (Continued).

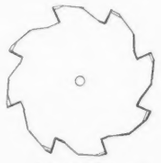
E. R. MARKHAM.

It is the intention of the writer to explain in a brief yet thorough manner the methods usually employed when making the various tools used in machine shop work; and he trusts that the skilled mechanic who has at his tongue's end the various methods here explained will patiently consider that it is for the many who have not been so fortunate as he that these articles are written. An article that would tell the skillful workman many things he does not already know would be of little benefit to those who are anxious to get the fundamental principles on which to build an experience that will be of value to them. Now a certain principle that may be fully explained under the heading of reamers may apply to similar operations as applied to other tools; but in cases of this kind the explanation will not be repeated, as under such circumstances the series would have no ending. For this reason we request that the reader who is anxious to learn as much as possible will try to impress on his mind the methods here given and apply them to other articles where the description is omitted.

In our last article we stated that it was formerly considered necessary to give *fluted* reamers an uneven number of cutting teeth to avoid chattering when the tool was in use, but that experience had proved that a reamer having an even number of teeth *unevenly* spaced worked as well and was easier to make. It could be ground to size at less expense, because the teeth were directly opposite each other, which made it possible to gage the size by means of a micrometer without removing the work from the cutters of the grinding machine—the unevenness of spacing being between adjoining teeth.

In cutting the teeth an uneven distance apart we move the index pin a different number of holes for each adjoining pair of teeth. The variation from even spacing, as before stated,

Fig. 1.



Industrial Press, N.Y.

Fig. 9.

should be from 2 to 4 degrees. To illustrate the method referred to of getting the irregularity we will take as an example a reamer to be cut with ten teeth. Supposing the milling machine to be used has an index head which requires 40 turns of the index pin lever for one revolution of the spindle. Then with the index pin set to the circle on the dial containing 18 holes we find that in making one revolution of the index-head spindle—which is, of course, equivalent to one revolution of the reamer being cut—the index pin must pass 40×18 holes $= 720$. As there are 360 degrees in every circle we divide 720 by $360 = 2$. It is apparent that a movement of two holes, with the index pin in the 18 row of holes, moves the work being operated on through one degree of space. If we were to mill 10 equally spaced grooves in the reamer then we would make a movement of four revolutions of the index pin each time, which would give us a movement of $4 \times 18 = 72$ holes or 36 degrees, which is exactly one-tenth of a circle. As we have the teeth unevenly spaced we first cut a tooth, then revolve on index head one-half revolution by revolving the index pin 20 revolutions and cut the second tooth—as shown in Fig. 1, directly opposite the first. We next move the index pin 64 holes and cut the next tooth; then revolve the head one-half revolution and cut the opposite groove. As a movement of 72 holes would give an equal distance between cutting edges it is apparent that moving 64 holes would cause an irregularity of spacing of 8 holes, and as each hole represents ½ degree the irregularity would amount to 4 degrees. Our next move will be 68 holes, which will require 3 entire revolutions of the index pin and an additional movement of 14 holes. As our previous move was 64 holes and this is 68, we have a variation of 4 holes, or 2 degrees. We next move 76 holes, then 80 holes for the last groove, and we find it would require a movement of 72 holes to carry us to our first groove. Now if we add the different number of holes moved to cut the various grooves we find we have moved the sum of 64 68, 76, 80 and 72 holes, which is 360 holes or 180 degrees, which is one-half circle. And as we cut the two teeth opposite each other every time we made an irregular spacing we would pass through an entire revolution of a circle—360 degrees or 720 holes.

Thickness of Land. When cutting the flutes of reamers with the form of reamer cutter mentioned in Article 1 the depth should be so gaged that the land will be about 1-5 the average distance from one cutting edge to the next. This will necessitate cutting some of the grooves deeper than others, as the irregularity of spacing causes an unequal distance between adjoining cutting edges. If the flutes are cut deeper than mentioned the lands will be thin and weak, and will spring when in use; and if they spring out into the work being cut they will stick and break. If they are cut much shallower they do not form a sufficiently large receptacle for chips.

Hardening Reamers. Extreme care should be exercised when hardening reamers, to avoid springing. Tools of this character should *never be overheated*, as it leaves the cutting edges brittle and unfit for use. If the necessary facilities are at hand the best results will be obtained if the reamer is hardened by the process known as "pack hardening;" but if this is not feasible we must heat very carefully and harden in the usual manner. With a muffle furnace at hand a uniform heat may be obtained very easily; but if obliged to use a blacksmith's forge the reamer should be placed in a piece of gas pipe, or tube, to prevent the fire from coming in contact with it. This method also prevents the air from the blast from striking the edges and causing them to crack. It is necessary to frequently turn the pieces that are being heated.

When uniformly heated to the desired temperature the reamer may be taken and plunged into a bath of water, or brine, from which the chill has been removed. It should be in as nearly a vertical position as possible, to avoid springing; when pieces are dipped at an angle the bath acts unequally on the opposite sides and consequently these contract unequally, which causes them to crook. The pieces should also be worked up and down in the bath somewhat, as this prevents the steam generated by the contact of the red-hot steel and water from forming a cushion around the reamer and keeping the water from it. If the reamer is larger than ⅞ inch diameter it should be held over the fire immediately after being taken from the bath, to remove strains set up by the hardening. Another method consists in removing the reamer from the water bath when it stops "singing" and immediately plunging in a bath of oil, allowing it to stay there until it is reduced to the temperature of the oil. The temper should be drawn to a straw color.

Should the reamer spring when hardening it may be straightened by applying pressure to the convex side after heating, the reamer being held between the centers of the lathe. This method of straightening hardened work will be more fully explained in the article on counterbores.

Grinding Reamers. When articles having centers in the ends are hardened, scale and dirt collect in the centers, and in order to get satisfactory results when grinding it is necessary to clean the center holes. This may be done by grinding a three-cornered file to a point at the end and using it as a scraper. Should the article be ground while dirt and scale are in the center holes it would in all probability run out so badly that it would not be possible to "clean" it when grinding. But should there be plenty of stock to allow of truing, some of the dirt might become loosened when the piece was being ground, and either change its location or fall out, and in either case it would cause the piece to again run out of true.

When possible it is advisable to grind work in a machine having two *dead* centers. All universal grinders are made this way. When a piece of work is ground in a lathe or other machine having one *live* center, there is a liability of the cen-

ter not running true, or of the spindle which contains the center being out of round, in which case it will duplicate its shape on the article being ground. Then again the irregular draw of the belt does not affect the shape of the piece when the spindle is *not revolving*.

Be sure the centers of the grinding machine are in good shape, and to gage. The reamer should first be ground to run true; and to accomplish this place the dog on the cutting end of the reamer and grind the shank to size, then place the dog on the shank end and grind the body to within .001 or .002 inch of finish size. Small reamers are given the less amount and large reamers the greater. Having ground the body to the dimension mentioned, we proceed to back off the cutting edges for clearance; and to make the clearance as straight as possible we use as large an emery as can be used without striking the cutting edge of the tooth next to the one being ground. In order to get the correct clearance we rest the face of the tooth being ground on the guide finger, which can

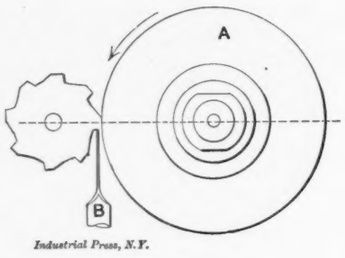


Fig. 2.

Fig. 3.

be adjusted to give any desired amount of clearance. Fig. 2 shows an end view of a fluted reamer being ground for clearance. *A* represents the emery wheel, which should be run in the direction of the arrow, so that the tooth of the reamer may be pressed down on the finger *B*. Should it be run in the opposite direction it would tend to draw the tooth up from the finger and cut away the cutting edge—thereby spoiling the reamer. However, when using a dry grinder—that is, one where water is not run on the emery wheel—the danger of heating the tooth and drawing the temper is greater when the wheel is run in the direction shown in Fig. 2; but if the face of the wheel is kept free from glaze, and ordinary care is exercised, there is little danger of starting the temper, provided we use a free cutting wheel that is not too fine. To give the tooth the proper clearance the finger is adjusted to bring the cutting edge below the line of centers, the dotted line denoting this. Do not attempt to remove too great an amount of stock at a cut; rather, take more cuts, going way around the reamer each time the adjustment is altered.

When grinding reamers for clearance it is absolutely necessary to rest the face of the *tooth being ground* on the finger, otherwise the teeth, being irregularly spaced, would not be ground with an equal amount of clearance. Neither would the cutting edges be the same distance from the center were we to rest on the tooth next to the one being ground, as shown in Fig. 3, as is done sometimes when work is being ground that has evenly-spaced cutting teeth. But in any case it is not advisable to rest on any tooth face but the one being operated on.

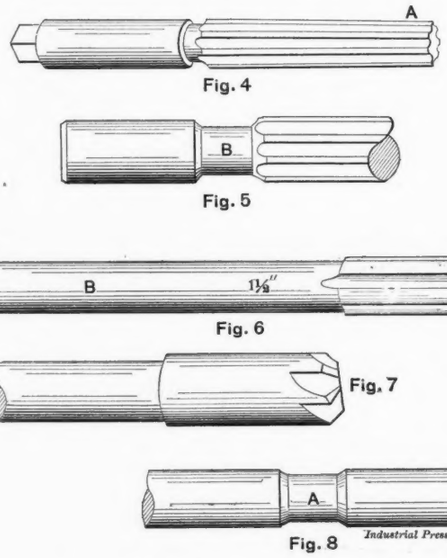
To insure fluted reamers maintaining their size when in use the clearance should not be ground to the edge of the teeth, as though it were a milling machine cutter; it should be ground to within .01 or .015 inch of the edge, the amount left depending on the size of the reamer. However, if the reamer be very small it is best not to leave more than one-half the first amount mentioned. To bring the clearance to the edge use an oil stone. It is necessary during this operation to stone to the desired size, which may appear to some a slow and costly way, but if a free cutting stone of medium grade is used for removing the stock, it can be accomplished in short order. In order to get an edge that will produce a smooth hole and stand up, use a fine stone for finishing. Do not, under any circumstance, use the stone dry; neither should it be allowed to glaze. The face of the stone being used should be flat, and free from indentation of any sort if satisfactory results are desired. It may be trued up by grinding on a wet grinder.

Do not give the cutting edges of a fluted reamer any more clearance than is necessary to insure its cutting freely. Too much clearance makes a weak edge, which chatters and soon loses its size.

As fluted reamers differ from rose reamers in that the latter cut on the end, it is necessary to taper them somewhat for a distance from the end in order that they may enter the hole to be reamed. This taper is represented at *A* in Fig. 4. As this form of reamer is not intended for removing much stock the taper should be very slight. This portion is, of course, given clearance the same as the balance of the tooth. When stoning the point where the taper and straight part of tooth join, it should be slightly rounded so as to avoid making a mark in the hole being reamed. This should be very slight, yet enough to break the abrupt end of taper and commencement of the straight portions.

While the instructions just given relate to fluted hand reamers, they apply in principle to fluted chucking reamers. The shanks of the latter, however, may be turned to size before hardening without leaving any allowance for grinding unless they are to be held in chucks of some form of holder. In this case they must be left somewhat large, and be finished to size after hardening, to insure their running true when in use.

When fluted reamers are intended for use in the lathe, and are not to be held in a chuck or any style of reamer holder, they are ordinarily made of the form illustrated in Fig. 4. When they are to be held in a holder as when used in a drill press, screw machine or chucking machine, they are made as shown in Fig. 5. In this style of reamer the portion to be



Figs. 4 to 8. Fluted and Rose Reamers

placed in the holder should be ground after the reamer is hardened, to insure its running true; and on this account it should be left .010 to .015 inch larger than finish size. The portion necked below the body and shank, which is marked *B*, may be turned to the size called for on the drawing, and finished. The size of the reamer and any distinguishing marks needed may be stamped on this portion, care being exercised, however, not to spring it by this operation.

Reamers that are held rigidly at the end of shank are, for several reasons, liable to cut holes somewhat larger than their own size. For this reason in many shops all reamers used for chucking purposes are made somewhat smaller than the hole to be reamed for finish, and after running these through the hole, "standard" hand reamers are used to produce the finished hole. Many mechanics claim this precaution is unnecessary, contending that any hole which must be of exact size should be left a trifle small and lapped to size. However, as this is a matter of opinion, and must be determined by circumstances,

we will not discuss it, but will give the required amount to leave for the hand reamer, if it is thought necessary to finish the hole with this rather than with the chucking reamer. The amount of stock to leave for the hand fluted reamer varies according to the custom and notions in the individual shop, and the tool maker must be governed by the ideas of those in whose employ he may happen to be. But in order that he may have some idea of the amount necessary we will give the custom in a shop using many reamers on all classes of work: For reamers under ½ inch .002 inch is allowed; between ½ and ¾ inch .003 inch; between ¾ and 1 inch .004 inch; between 1 and 2 inches .006 inch. For reamers larger than 2 inches diameter .008 inch is allowed. As these amounts are not considered proper to produce good results in other shops no exact amounts can be stated arbitrarily, but the conditions existing in each shop, the stock to be cut, etc., must determine how much stock the finish-reamer must remove. However, if we are to take out only the small amounts mentioned for the small reamers, the holes will have to be smooth and in good condition before we ream them, or we shall not be able to correct any imperfections that may have existed.

Rose Reamers.

The form of reamer known as "rose reamer," Fig. 6, has its cutting edges on the end, as shown. The grooves which are cut the entire length of the body serve the purpose of reducing the amount of bearing surface in the reamed hole, and also furnish ways to conduct the oil or other lubricant to the cutting portion. Rose reamers were formerly made without the grooves, as shown in Fig. 7; the body of the reamer was solid, with the exception of the cuts made to form the teeth at the end, and for this reason they caused a vast amount of annoyance by "wringing up" the stock in the hole of the piece being reamed. This trouble has been done away with, however, by the reduction of frictional bearing effected by cutting the grooves.

Reamers of this character will cut a hole that is nearer parallel than is a fluted reamer, when there are blowholes or other irregularities of surface in the walls of the hole being reamed.

In some shops it is customary to use a rose reamer a few thousandths of an inch smaller than finish size, before using a fluted reamer, thus insuring the proper amount of stock to remove with the fluted reamer, which does not work well if it has too much stock to remove when cutting.

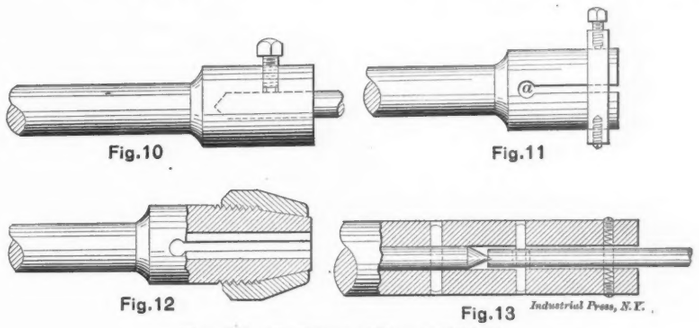
Small rose reamers for use in an emergency are oftentimes made from a piece of drill rod of the right size. This is cut to the proper length, placed in a chuck on the lathe and the end is beveled the proper amount for the cutting lips. The grooves may be filed with a three-cornered or round-edge file, the cutting edges backed off, and it is then ready for hardening. It is advisable to harden up for a distance as great as the reamer is to enter the work, or it will "rough up" when in use. If the reamer is to be used in reaming *long* holes it is advisable to neck down a short distance back from the cutting edges as shown at *A* in Fig. 8, and have the hardening end in this necking, as a peculiarity of drill rod is that it apparently expands at the point where the hardening stops, and if it stops in the smaller part it will not bind in the reamed hole. These remarks of course apply to reamers that are not to be ground to size after hardening.

When making the ordinary form of rose chucking reamer shown in Fig. 6 we select stock enough larger than finish size to allow the removal of all the decarbonized portion. After turning a roughing chip all over the piece, the shank *B* may be turned to finish size, unless the reamer when in use is to be held in a chuck or other holder, in which case there should be sufficient stock left to true by grinding after the reamer is hardened. When rose reamers are to be used for reaming holes that must be exact as to size they must be ground to correct size after they are hardened. To prevent them from binding in the hole being reamed it is advisable to grind them a trifle tapering, making the body 1-4000 inch smaller on the end next to the shank. A greater amount of taper would not do, as the reamer would not be sufficiently supported in the hole when in use, and might run.

When rose reamers are made from drill rod and are *not* to be ground after hardening, the necessary clearance to give the cutting edges may be obtained by filing. Make sure that the clearance goes to the edge, as otherwise the tooth will not cut. Care must be exercised also not to file too much. This would reduce the length of the tooth, as one tooth would be shorter than the others and would not do its share of work. Cutting tools having more than one cutting edge should be constructed so that each edge does its proportional amount of work. If reamers are ground to size the cutting edges should be given clearance by grinding also, thus insuring teeth whose lengths are exactly alike. The bevel given the corner produces a point where it meets the straight part of the body, Fig. 6, and this point it would produce a scratch in the hole being reamed; so this sharp corner must be removed by means of an oilstone, to insure smooth walls in the hole.

Large rose reamers, and those to be used in reaming brass and the various other alloys of copper, should have the lands of about the width of fluted reamers. The bearing surface of the lands must also be reduced, which may be accomplished by filing, commencing at the heel of the land and filing a clearance to within a short distance of the opposite edge. The distance left untouched varies with the character of the work to be reamed, but for most purposes 1-32 inch would be about right. The neatest method of giving the land the clearance mentioned, however, would be by grinding, leaving it as shown in Fig. 9. The amount of clearance in this sketch is exaggerated, so as to illustrate the principle. It need be only sufficient to insure the reduction of frictional resistance, which is very pronounced when reaming the softer metals.

Reamer Holders. When reamers are operated by hand they are held in a reamer or tap wrench. When used in an engine lathe they are sometimes held with a wrench, and at other times, placed in a drill chuck. When used in a drill press they are held either in a chuck or a collet having a hole in the end the exact size of the reamer shank. The shank must fit exactly in the hole, and the hole must be true with the collet. We might carry this line of reasoning still further and say that the spindle of the press must be true, but this is outside the intended scope of these articles.



Figs. 10 to 13. Forms of Reamer Holders.

When reamers are used in the screw machine, or chucking machine, they are held in reamer holders. Of these there are several styles, the simplest of which is shown in Fig. 10. It is ordinarily made from machine steel, one end of which is turned to fit the hole in the turret while the opposite end is turned to finish size. A hole is bored in the end to receive the reamer shank, the reamer being held in place by a setscrew. When fitting tools of this character to holes in the turret it is advisable to test the holes for size. If there is any variation, fit to the proper hole, then mark the holder to correspond with the hole it is fitted to.

A second form is shown in Figs. 11 and 12. In this holder the reamer is held by closing the sides of the holder onto the shank. These jaws are closed in Fig. 11 by means of the collar and setscrew, while in Fig. 12 the ends of the jaws are tapered and a nut with a tapered hole forces the jaws together. A third form is shown in Fig. 13 and is generally termed a "floating" reamer holder, because the reamer is not held rigidly in position. The object attained in using a holder of this form is that, should the turret holes not line perfectly with the head spindle, the reamer is free to adjust itself to proper alignment, thus doing away with the tendency to ream

a hole somewhat larger than its own size at the outer end of the hole.

When making the holder shown in Fig. 10, a piece of machine steel somewhat larger than finish size is used. After turning a roughing chip over the piece one end is fitted into the hole in the screw machine turret, the other end turned to size and the large end run in the back rest of the lathe, while the opposite end is strapped back against the live center. The hole in the end that receives the reamer is drilled and bored to size. Previous to strapping the work against the center, test the center to make sure that it runs true. If it does not, it should be trued before proceeding, for the hole bored in the end would not be true if the center were not true. Care must be taken when fastening the piece back against the center not to draw it to one side by careless methods of strapping; this would also cause the hole to be bored out of true.

If the hole to be made in the end that is to receive the reamer is sufficiently large it should be bored to size with a boring tool rather than attempting to ream it, as a hole more accurate as to size and concentricity will thus be produced, unless we are certain that our lathe spindles are in perfect alignment and the reamer we are using is exactly straight. Many times we find lathes that have been in use for some time have not remained in line, and in fact we occasionally find a new lathe whose spindles are not in line with each other. Now, if the head and tail spindles of a lathe do not line with each other—that is, if one is lower than the other—by moving the tail block in or out we can compensate for the amount the spindles are out of alignment and turn a piece of work straight; but if we attempt to ream a hole in a piece attached to the head spindle by placing the center in the shank end of the reamer on the dead center, when the two spindles are not in alignment, the results will not be satisfactory.

If it is found by trial that the spindles are perfectly aligned, and it is considered advisable to ream the hole, first drill it somewhat small, then by means of a boring tool, bore it to within a few thousandths of an inch of size, to insure its running true. It would not be safe to drill a hole to reaming size, and then ream it without boring, as the drill is almost sure to run somewhat, no matter how much care may be exercised. There is no assurance that steel or iron is perfectly homogeneous, and a soft or hard spot in the stock would cause the drill to run out; for this reason it is always necessary to bore the hole with an inside turning (boring) tool, to make it concentric with the outside of the piece.

When reaming holes that must run true many mechanics take the precaution to bore the hole to a size at the end—1-16 inch or so—that allows the reamer to be wrung in, as shown in Fig. 14, thus insuring its starting true; and if a rose reamer is *started* true there is every reason to think it will produce a true hole, provided the reamer is straight and in good condition and the spindles are in alignment. Other mechanics who are perhaps equally skillful do not consider it necessary to let the reamer in with the boring tool, but by means of a tool held in the toolpost of the lathe they chamfer the end of the hole, as shown in Fig. 15, to an angle that corresponds to the angle of the cutting edges of the reamer.

A rose reamer will, as a rule, make a hole true to size. If started true the liability of its "running" is reduced to a minimum on account of the large bearing surface it has on its lands which, not being backed off, fill the hole and steady it. This overcomes in a great measure the reamer's tendency to run when it strikes a hard or soft spot, as is the case with a fluted reamer or a drill, which are not supported by the lands—at least not to any considerable degree.

After the hole has been brought to size the holder may be removed from the lathe and the hole for the setscrew drilled and tapped. The burrs are then removed, and when the setscrew is in place it is ready for use. As the pressure of the setscrew is all in one direction the shank of the reamer must fit very nicely in the hole in the holder; the holder must also fit well in the hole in the turret.

To overcome the tendency of the setscrew to throw the reamer to one side, unless the fit be perfect, holders are often made as shown in Fig. 11. The same general instructions given for the other form apply to this except that instead of using a setscrew we drill a hole, *a*, and split the holder as shown. It is quite necessary that the drilling of the hole and cutting of the slots be as nearly central as possible in order that the holder close in a manner that will bring the reamer central. Should the hole *a* be nearer one side of the holder than the other, one side would offer less resistance than the other and the reamer would not be concentric with the holder. Should both sides of the holder not close equally this style of holder is no better than the one using the setscrew to hold the tool.

There are several methods employed when drilling the hole and sawing the slots in holders of this character. The more common way is to center-punch on one side and then drill it in a speed- or engine-lathe, holding the piece in the V-center. The result of using this method would in all probability be a hole drilled to one side of the center of the piece. A better method would be to clamp the holder in a pair of V-blocks on the drill press table, as shown in Fig. 16, locating the punch mark so it is equi-distant from the sides. This can be accomplished by measuring from a square blade placed against the work, as shown, measuring the distance from the blade to the punch mark and setting it so that it measures the same from each side. First drill with a small drill, then follow with a larger one; although a surer way would be to follow with a counterbore. But even with the utmost care the drill is liable to "run" and produce a hole that is not central; so the safest way to drill the hole is to put it between the centers on the

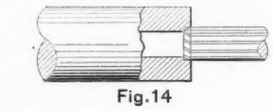


Fig. 14

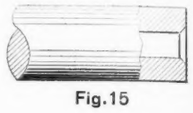


Fig. 15

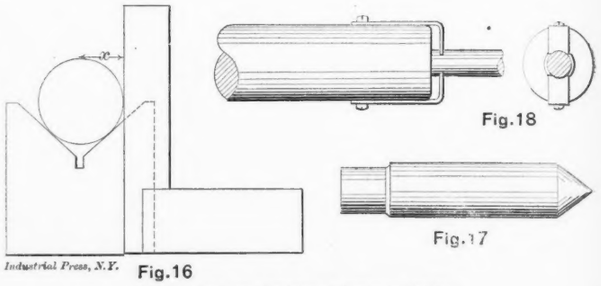


Fig. 18

Fig. 17

Fig. 16

Figs. 14 to 18. Making a Reamer Holder.

milling machine, and drill it by means of a drill held in a chuck, or a collet in the spindle of the machine. The point of the drill should be set at the height of the point of the centers, and when starting to drill, should be set well back in the chuck, having not more than one-half inch of the straight part projecting beyond the jaws. This is to prevent it running when "spotting the work," or in other words, when locating the hole. The work is fed to the drill by means of the cross feed screw handle. Having drilled the hole deep enough to allow the body of the drill to enter the work, withdraw the work and revolve the centers one-half revolution and "spot" the opposite side. The drill is then set out from the chuck and the hole drilled through the walls of the holder, each side being drilled separately from the outside toward the center.

In order that the slots which allow the holder to close together may appear well, hold the piece in the centers, using a metal slitting saw. Set the saw in center of the drilled hole, cut one slot and then revolve the center-head one half revolution and cut the other slot. If this slot were not in the center it would not affect the accuracy of the holder, but how much more mechanical such a piece of work looks when it presents a favorable appearance, and, as a rule, a workman who is slack regarding the appearance of his work is not careful as to essentials. Moreover, as it takes no longer, generally speaking, to do a thing right than to do it in a "slip-shod" manner, it is advisable to cultivate carefulness, not only as to accuracy but as to appearance.

The collar containing the screw used in closing the holder needs no description or explanation as to its construction, as any one can readily see how it is made. Put the small screw shown in cut, in the collar, tapping it into the holder.

This holds the collar in place and prevents its being lost when the holder is laid away if the tension be removed from the setscrew.

When making the form of holder shown in Fig. 12 the same general instructions should be observed, when turning the outside, as with the holder shown in Fig. 11, with the exception of the tapered end and the threaded portion to receive the cap nut used in closing the jaws of the holder. The nut, which is generally made from machine steel, should be made and casehardened before cutting the thread and turning the tapered portion. Casehарden work of this character by dipping in oil rather than water, as the liability of change of shape is then greatly reduced, and the nut will be much stronger.

When possible turn the necessary tapers on this class of work on a lathe having a taper attachment, or a compound rest—preferably the former; the setting over of the dead center is liable to cause the center of the piece being machined to become distorted, thereby throwing the work out of true, i. e., causing one portion to be out of truth with another portion. When there is but one taper to turn on a piece of work it can be accomplished very nicely by setting the dead center over and turning the taper before the straight portion is turned. Then when the centers are placed in line, test the tapered portion before turning the straight portion, and should it prove to be out, the center in the end may be scraped with a three-cornered scraper until the portion runs true. The straight portion may then be turned, and the two will be true one with the other. But where two tapered portions are to be turned on the same piece of work trouble may be experienced unless extreme care is used and the condition of the piece is noted after each operation. Work of this character can be done on lathes having no taper attachment or compound rest, and done in a satisfactory manner, but greater care must be exercised, and the work must be tested after each operation of taper turning.

For the style of holder shown in Fig. 13 we proceed the same as for Fig. 10, when turning the outside portions. The hole in the holder, however, should be somewhat larger than the reamer shank, as shown, but should be concentric with the outside in order that the point of the center may be true with the holder. The center is made from tool steel—a cheaper grade will answer as well as the better quality. It should be turned to a size .010 to .015 inch larger than finish size, and should then be back-rested and the point turned. After this it may be hardened and the temper drawn to a brown color. Harden the entire length of bevel; the angle can then be gaged much more readily when grinding. If it were hard for a part and soft the balance of the taper, the emery wheel would not act alike on the hard and soft portions.

When turning in the lathe it is advisable, when allowable, to turn a portion of one end slightly smaller than finish size, as shown in Fig. 17. When grinding the straight portion to size the dog may be placed on this portion and the straight part ground the entire length. Use a female center for the pointed end, when grinding the straight portion, and after grinding this straight portion, the piece may be back-rested in the grinding machine and the beveled end ground to its proper angle, true with the straight portion.

Now the center may be placed in the holder as shown and a hole drilled through the holder and center and a pin driven in to prevent the center being pressed back, from the force used to cause the reamer to cut. The center, when ground, should be a close fit in the hole; in fact it should be necessary to use gentle blows of a babbitt hammer to drive it to place.

A pin should be driven tightly into a hole in the holder to keep the reamer from turning. The hole in the reamer through which it passes should be considerably larger than the pin; if the pin is ¼ inch diameter the hole should be at least 9-32 inch. For larger size pins the hole should be corresponding above size.

Coil springs are used to keep the reamer central with the holder so that it may readily enter the hole to be reamed. These springs are placed in holes which are tapped to receive screws to give the springs the desired tension. Some mechanics object to the coil springs, claiming that fine chips in the form of grit find their way into the holder, and prevent the springs acting properly. They claim best results with springs made as shown in Fig. 18, which being fastened to the outside of the holder on opposite sides pass over the end and engage with the reamer.

There are other styles of holders in use but those shown give an idea of the operation necessary in making most forms.

* * *

ITEMS OF MECHANICAL INTEREST.

A SPECIAL SHAPER JOB—INSULATING COUPLING—MARINE ENGINE MODEL—DRIVING SCREW SPIKES.

In the operation of New York's electric surface railways, it has been found that the electrical power for propulsion costs less than seven per cent of the total operating expenses.

Twist drills hardened in a water bath should be plunged deep enough to harden a short distance on the shank. Water cracks are apt to occur if the drills are held almost stationary in the water. If the drills are soft, directly back of the water cracks, it is proof that this portion was held at the water line or so close to it that they did not go into the bath deep enough to harden.—*Sparks from the Anvil.*

A SPECIAL USE FOR THE SHAPER.

The accompanying illustration shows the adaptation of one of Gould & Eberhardt's shapers, to work which had previously been considered a milling-machine job.

The machine was designed for cutting the grooves in composition trolley ears, such as are used for suspending trolley wires, and sample ears are shown on top of the vise in the illustration. The machine was gotten out for a large manufacturer, who had been using a milling machine, but wanted to increase his output. With the shaper he has been able to almost treble the output of his milling machine.

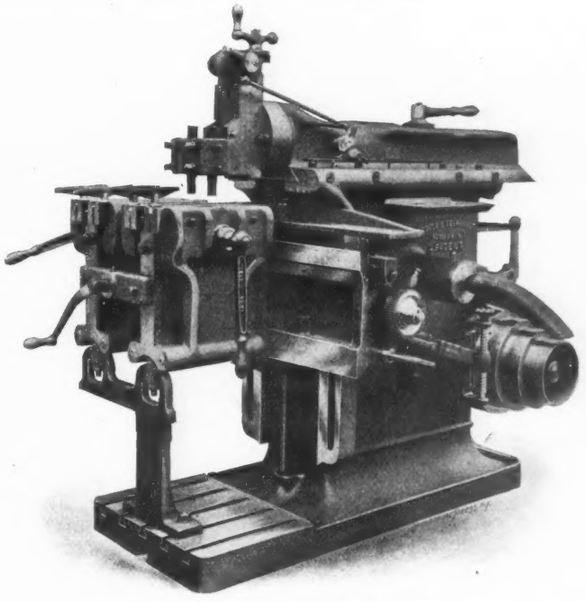
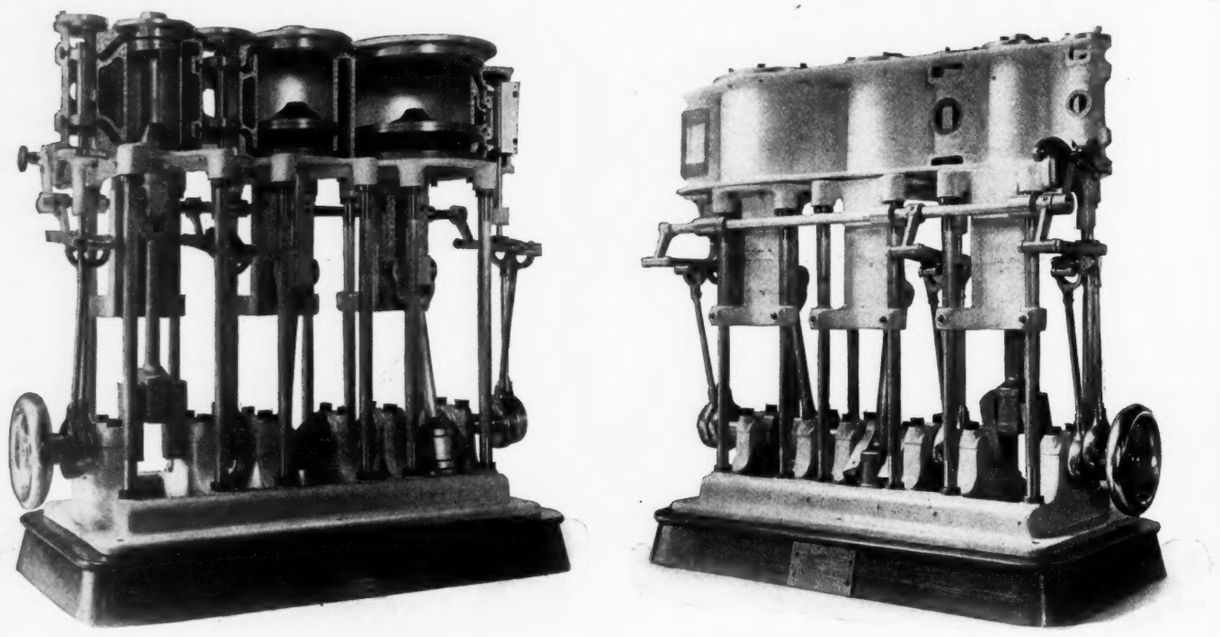


Fig. 1. Cutting Grooves in Trolley Ears.

The shaper is a standard machine, with a special table and tool head. These can be replaced by the regular table and head, and the machine used for ordinary shaper work when required. There are two sets of two vises, four in all, for holding the ears, the jaws of the vises conforming to the shape of the ear. The grooves in two of the ears are planed at one time, the machine being provided with a double tool holder. While this operation is going on the operator removes the ears from the other set of vises and replaces them with blank castings. The tool head has an automatic depth stop, and instantaneous return. As soon as the grooves are planed in the two ears the operator moves the other set of vises over in position, by means of the crank handle on the front, which operates a pinion and rack. The table is provided with a stop at each end which insures its being located

centrally under the tools when moved. In the meantime the tool head has commenced to feed down, but there are a sufficient number of strokes allowed for the operator to move the vise over before the tool reaches the work. This machine will plane grooves ⅜-inch wide by 17-32-inch deep and 15 inches long, from the solid casting, at the rate of one every forty seconds.

turned by the hand wheel at the left. The Stephenson link motion is employed for reversing and is operated by a hand lever and knob at the rear of the cylinders. The entire model is about 30 inches in height and is mounted on a neat wooden base. The materials of construction are in nearly all cases the same that would be used in actual practice. All of the steel work is polished and the external cast-iron parts are



Figs. 2 and 3. Front and Rear View of Marine Engine Model.

INSULATING COUPLERS FOR MOTOR GENERATORS.

In a description of the transforming and distributing station of the Montreal Light, Heat & Power Co., published in the *Canadian Electrical News*, an insulating and flexible coupling for motor generators is illustrated. It consists of the steel castings *AA'* keyed upon the shafts *CC'* to be coupled. Each casting has eight ears which engage those of the opposite casting through the medium of the rubber rolls *BB*, etc.,

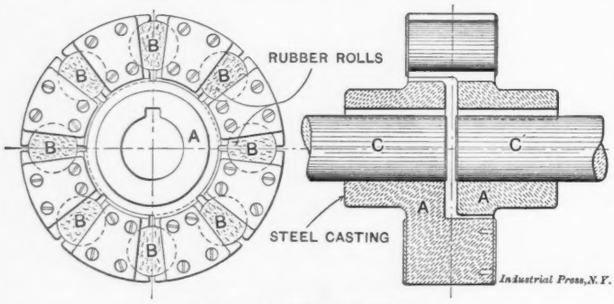


Fig. 4. Insulating Coupling.

which are interposed to prevent metallic contact, but which have strength sufficient to transmit the torque. The sides of the ears are grooved to the arc of the rolls and nearly encircle them. Plates over the ends retain them in the recesses and give further support to the rubber rolls. There is of course little flexibility to this coupling, the chief aim being to secure the insulating effect.

TRIPLE EXPANSION MARINE ENGINE MODEL.

Figs. 2 and 3 show the front and rear views of a very interesting model of a triple expansion engine, of the marine type, which was recently furnished the Japanese government for use in the Japanese Naval College. The model represents, to a reduced scale, an engine having cylinders 24, 39 and 60 inches in diameter by 39 inch stroke, and this has been reduced to one-twelfth, giving cylinders 2, 3¼ and 5 inches in diameter by 3¼ inch stroke. The three cylinders and their steam chests are cut open on the front so that their relative movements may be observed as the crank shaft is coated with white enamel paint, so that the engine presents an exceedingly neat appearance as well as affording a correct model for instruction. It was designed by the Gardner Engineering Co., New York City, and built by the Grant Mfg. & Machine Co., Bridgeport, Conn.

MACHINE FOR DRIVING SCREW SPIKES.

Two interesting machines have been built at the Washburn Shops of the Worcester Polytechnic Institute during the last few months under the direction of the United States Bureau of Forestry. These machines are designed for driving screw spikes into railroad ties, and were designed at the Worcester Polytechnic Institute by Alton L. Smith, professor of machine design. The screw spikes are designed to replace the spike ordinarily used by railroad companies, and an effort will be made by the Bureau of Forestry to introduce their use into this country. They are already extensively used in France, Belgium, Germany and other European countries. The advantage of the screw spike lies in the fact that it will allow the use of softer wood for railroad ties than is possible where the ordinary form of spike is employed. The holding power of the latter depends entirely upon the resilience of the wood into which it is driven, and the pounding action caused by the passage of heavy trains over the rails will in a short time loosen the spikes unless the wood employed is firm and close-grained. Of late years the demand for chestnut, oak and other high-grade woods for railroad tie purposes has been so great that railroads have been confronted with a steadily rising price for their tie supplies, and they have been compelled to cast about for something to take their place. In this they have been assisted by the Forestry Department of the Government, which has been, and still is, engaged in an extensive series of experiments along these lines. If the machines which have just been built are successful it is expected that many of the softer kinds of wood, such as spruce and poplar, can be employed for railroad ties. With the old form of spike, experiment has shown that the life of one of these ties did not exceed six or eight months, but with the screw spike it is expected that they will last for some years. One of the machines in question was built for the New York Central, and the other for the Pennsylvania Railroad Company.

HOW AND WHY.

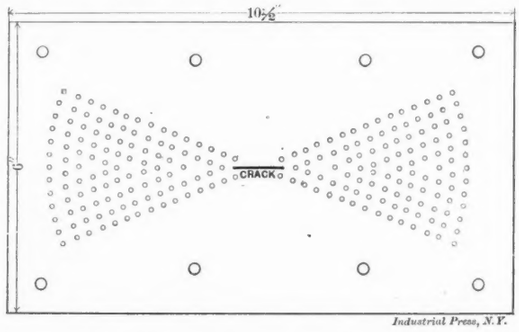
A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

14. W.—1. In hardening tools made of the new process steels, is an air blast employed or are the tools simply left to cool off in the atmosphere? 2. How can tools made of these steels be annealed?

A.—1. Tools of the new process steels should be hardened either in an air blast or in oil. Generally the former method is used for such tools as lathe and planer tools, while the oil bath is used for such tools as milling cutters, taps, etc.. For air hardening, bring the tool to a white welding heat and place it at once in a strong blast, holding it a few inches from the outlet. Do not remove the tool until it is quite cold. For oil hardening, bring the tool to a white pimpling heat, then lay it on the anvil or floor and allow it to cool down to a black heat, showing a dull red in shadow or dark place. Brush the tool off and place in the oil bath. Precaution should be taken in placing it in the oil, for if too hot the steel is liable to crack. 2. To anneal these steels, heat slowly but thoroughly to a yellow color and pack at once in a steel box or tube with dry fire clay so that the air cannot come in contact with the steel. Lime, charcoal and sea sand are recommended for use in place of fire clay, and if one of these substances does not give satisfactory results with any particular brand of steel, it is well to try one of the others. If an air-tight box or receptacle is available the steel may be annealed by heating it in this box and then allowing it to cool off slowly. It is a good plan to let the box containing the steel remain in the furnace while the fire is dying out.

15. D. M. M.—The accompanying sketch shows a perforating die that I made with very poor results. The die was 6 by 10½ inches by one inch thick, and cracked in hardening. The holes were 1-16 inch diameter and spaced ¼ inch. The die cracked at the point marked, and I am at a loss to know why it



Industrial Press, N.Y.

cracked at the heaviest place. I heated it in a charcoal fire to a cherry red and dipped it, side up. The bath was a large tub of clean water, with a half pail of salt in it. Any information that you can give me will be appreciated.

Answered by E. R. Markham.

The crack was the result, undoubtedly, of unequal contraction, there being a greater volume of stock between the point where the crack occurred and the sides of the die than at any other portion, and the contraction was not only greater, but continued for a longer time. As the die was cut away less at this point than any other the yielding space was reduced to a very narrow space. What is more natural, with a greater volume of stock to contract, and the portion cut away reduced to the minimum—as per the sketch—than that it should break at this point?

There are several methods whereby a die of this character can be hardened with comparative safety. The safest method, and one I have never known to fail, consists in hardening by the method known as pack hardening. This has been explained in several articles the writer contributed to MACHINERY, but as the application would be somewhat different in the case under consideration, it will be explained in a brief manner. Pack the die in a hardening box with granulated charred leather and subject to a low red heat in a furnace for about 3½ hours after the *die* is red hot. It may then be taken from the box and dipped in a bath of raw linseed oil. There should be a pump connected with the bath whereby a volume of oil can be forced against the face of the die and through the holes. The oil used should not be cold, but about 60 degrees Fahr. Since every shop is not equipped with the necessary apparatus to pack harden work satisfactorily, we will consider a method that can be applied anywhere, provided we have a suitable fire and a supply of water. First take a block of cast iron somewhat longer and wider than the die block, then cut out the center the shape of Fig. 1. The double angular-shaped opening must be about one inch larger each way than the perforated portion of die, which would make the opening one-half inch larger each way than the space taken up by the perforations. The die must be heated *uni-*

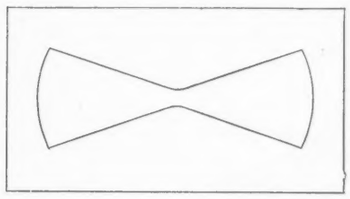


Fig. 1.

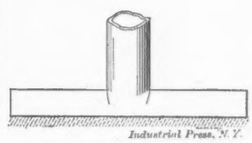


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Fig. 2.

formly to a low red, taken from the fire and laid flat with the face uppermost. It will be necessary to lay it on two strips of iron to block the back up somewhat, so the water that passes through the holes can run off readily. Place the cast-iron piece, Fig. 1, on the face of the die, having an equal space around the perforated portion, then by means of an overhead pipe like Fig. 2, a stream of water can be run onto the exposed portion of die; and, as the balance of the die is protected by the plate, it will not be hardened, consequently there will be no contraction to speak of that will have a tendency to draw the stock from the center.

If we have a tank of oil it is advisable to plunge the die in the oil as soon as the center is hardened and allow it to remain until cool. When cool reheat to remove strains, then draw temper. Do not use *cold* water. Water at about 70 degrees Fahr. will not be as liable to cause the die to crack.

16. S. H. S.—Are the rolls that are used for making steel plate of cast steel or iron?

Answered by J. W. Bourn, Philadelphia, Pa.

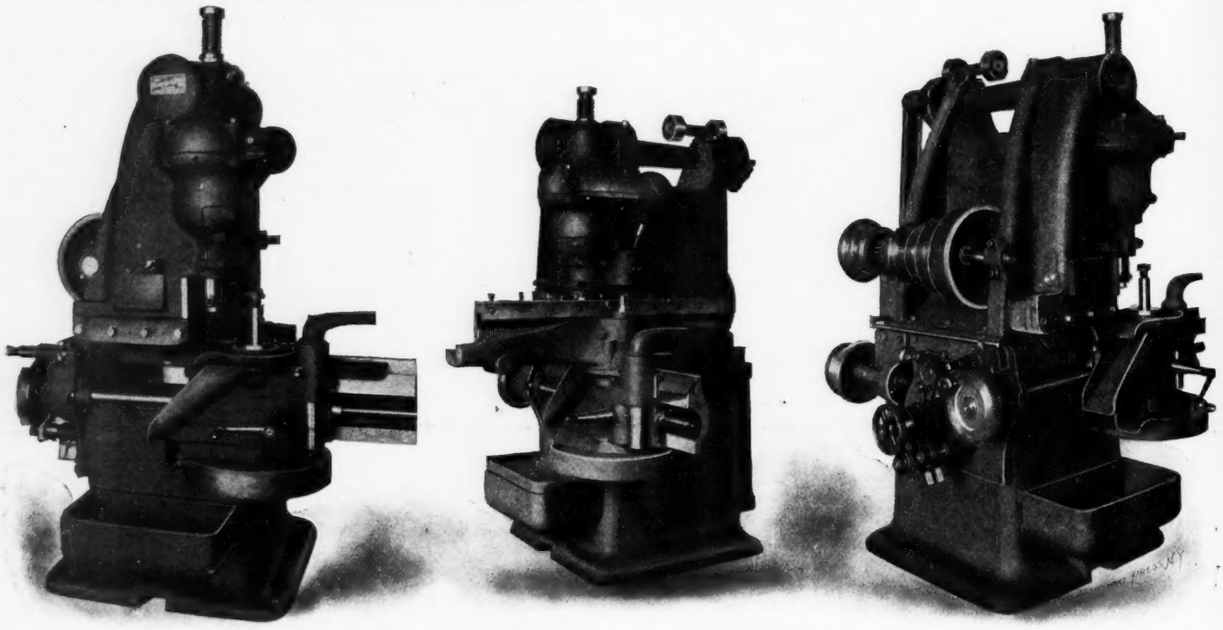
Rolls for steel, iron, brass, or tinplate are invariably made of chilled cast iron, while for rolling bars of various shapes and materials, steel rolls are quite extensively and successfully used, but they are more expensive than those of cast iron. The steel is too soft for plate rolling, and it is very difficult to obtain steel castings that will have perfectly clean surfaces when they are turned, it being a requirement of plate rolls of any description that the surface shall be practically perfect. To make a steel roll, either cast or forged, it would have to be hardened and ground after turning and in addition to being a very expensive job, it would not be very serviceable since, except for cold rolling which is comparatively rare, the hot metal would soon draw the temper and leave the roll too soft for use. Cast iron, on the other hand, can be cast without a flaw, turned easily and cheaply, and can be chilled to any depth, making a surface that cannot be softened by the heat of the plate. Steel rolls hardened and ground ready for use would probably cost from 50 to 60 cents per pound, with all the chances against their doing the work, while good chilled rolls have been known by the writer to be made as cheap as 7 or 8 cents per pound.

* * *

After many months of fighting, the Wabash R. R. some time ago secured entrance into Pittsburg. The railroad emerges from a tunnel through the hill opposite Pittsburg, crosses the Monongahela River on a double-track cantilever bridge, and enters the city hard by the old Hostetter plant, of stomach bitters fame. The bridge, which is now well along, will be the largest cantilever bridge in this country having a clear span of 812 feet over the river. It is said that the largest eye-bars ever made will be used in its construction. No false work will be erected for the river span.

NEW DESIGN OF FELLOWS GEAR SHAPER.

A gear shaper of new design has been brought out by the Fellows Gear Shaper Company, Springfield, Vt. It is a smaller machine than the original shaper which this company have manufactured since their inception six years ago, and is built to do rapid and accurate work on small and medium-size gears for his first machine. The cutter used is a tool-steel pinion, having teeth ground with a suitable rake and clearance, and as it reciprocates, both the cutter and blank are given slow rotary motions in the inverse ratios of their pitch diameters. The teeth of the cutter thus plane out teeth in the gear blank which are conjugate to the teeth in the cutter.



Figs 1 to 3. New Design of Fellows Gear Shaper.

of comparatively fine pitch. It will operate on blanks up to 24 inches in diameter and of 4-inch face, and is designed to cut teeth of 8-pitch and finer.

The machine is quite different in appearance from the larger one, and its mechanism is different in several important particulars. The same principle of tooth formation is employed, however, which Mr. Fellows so neatly worked out

In the original Fellows gear shaper provision was made for clearing the cutting edges of the cutter upon the return stroke by a slight backward-and-forward movement of the casting which supports the work arbor and carries the blank to be cut, this motion taking place at each reversal of the stroke of the cutter bar. In the new machine, however,

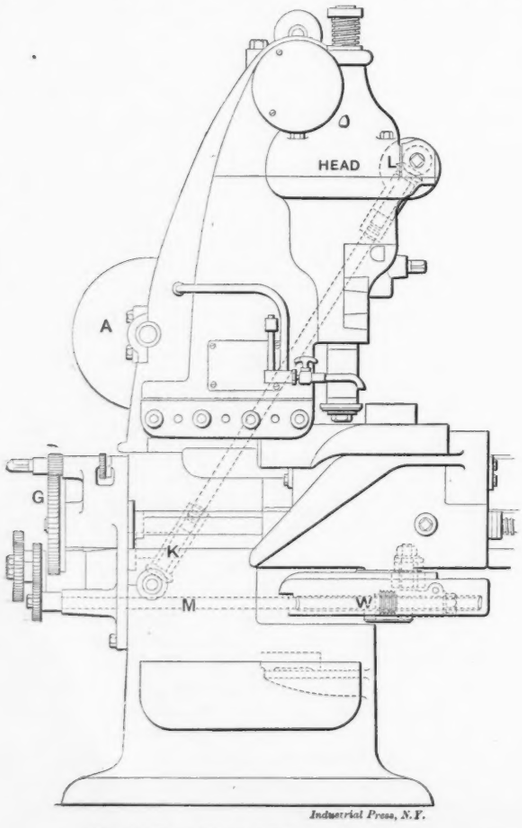


Fig. 4. Front View of Fellows Gear Shaper.

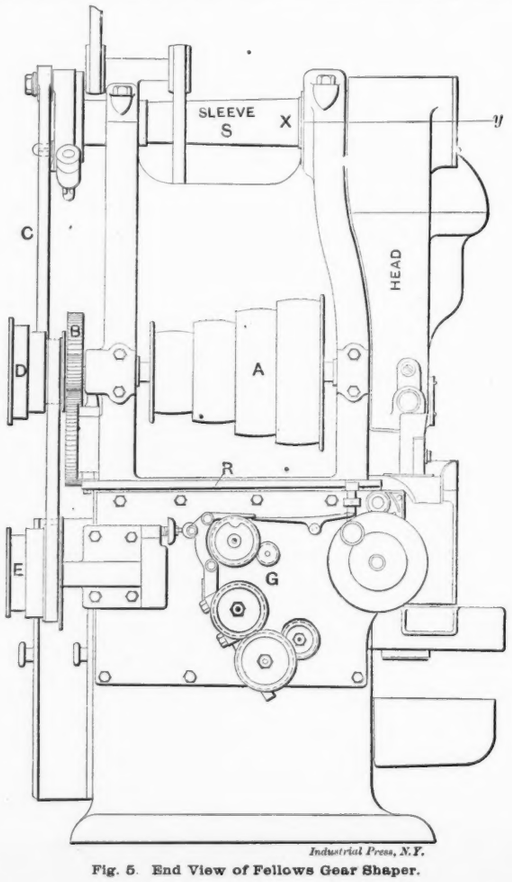


Fig. 5. End View of Fellows Gear Shaper.

the carriage remains fixed and the tool clearance is obtained by a slight rocking motion of the head, which carries the cutter bar. By this construction the machine is adapted for the use of a rack-cutting attachment, which is attached to the carriage, and receives its feed from a pinion on the work arbor. Owing to the reciprocating motion of the carriage of the older machine, no rack-cutting attachment was made for it, as it was considered that the carriage and rack-cutting attachment combined would be too great a mass to be moved back and forth rapidly at each stroke of the cutter. The new type of machine therefore has the advantage of the rack attachment, and at the same time is convenient and rapid for gear cutting within its capacity. It is not, however, adapted for cutting internal gears.

In the half-tone illustrations, Fig. 1 is a front view of the machine. The whole visible front of the upright constitutes the head, which carries the cutter bar and connections. The head is pivoted at the top and its rocking motion is derived from a small rotary cam at its base. The alignment of the head is maintained by a heavy gib which bears against a flat,

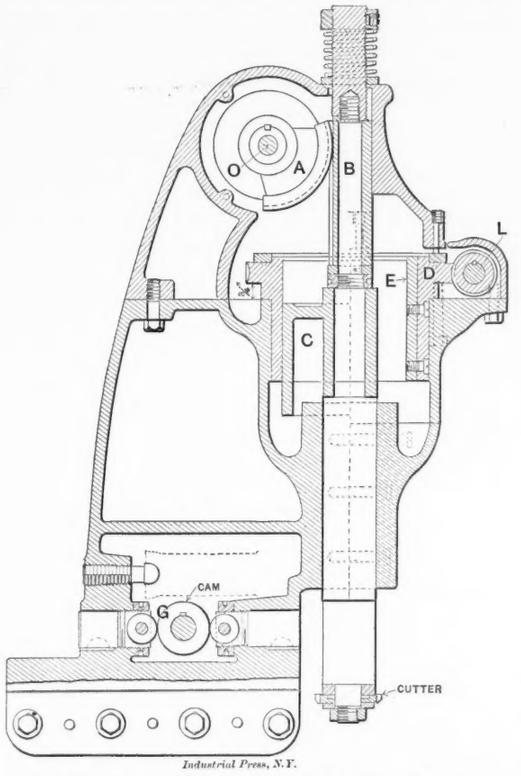


Fig. 6. Section through Head of Fellows Gear Shaper.

finished surface at the bottom. The carriage for supporting the work is carried by an overhanging arm, to which it is gibbed, and along which it can be moved for adjustment of the work to the cutter and for feeding the work against the cutter at the start. Channels cast in the carriage carry chips and lubricant to the pan bolted to the base of the machine.

Fig. 3 is an end view, showing the driving cone and feed gears, which in this machine correspond to the spacing mechanism of the ordinary gear cutter. This view also shows more clearly the arrangement of the gib at the base of the cutter head.

The middle view of the group, Fig. 2, shows the rack-cutting attachment in place. This consists of a frame, which fits over the work spindle and rests on the top of the carriage, and a heavy slide in which the rack blanks are clamped. This slide advances as the cutter rotates, deriving its motion from a pinion on top of the work arbor, which meshes in the teeth of the rack visible in Fig. 2 at the back of the slide. In Fig. 7 is a sectional engraving of the attachment, in which the different parts are indicated with sufficient clearness to make further description unnecessary.

Figs. 4 and 5, respectively, present a front and end view, in which corresponding parts are similarly lettered. Power is received at the driving cone *A* and transmitted through gears *B*, to a horizontal shaft parallel with the driving shaft, but not visible in the engraving. This shaft passes through the machine and at its right-hand end, Fig. 5, carries the cam for giving the head the oscillating motion. At its left-hand end is an adjustable crank, from which the connecting rod *C* transmits motion to a shaft passing across the top of the machine, through the sleeve *S*. This latter shaft thus has an oscillating motion which it transmits to the cutter bar by means of a rack and segment. At the left-hand end of the shaft referred to as being driven by gears *B*, is also a cam which gives motion by rod *R* to the carriage feed screw, and feeds the work against the cutter to the required depth, when beginning to cut a gear.

On the left-hand end of the driving spindle, Fig. 5, is the feed cone *D*, which is belted to cone *E*, connected with the feed gears *G*. This train of gears, *G*, gives the rotary motion to the cutter bar and the work arbor, the change gears used determining the relative rates of rotation of these two members. The motion is transmitted to the head for rotating the cutter bar by means of the inclined shaft *K L*, Fig. 4, and to the work arbor by the shaft *M* and the worm and worm-wheel *W*.

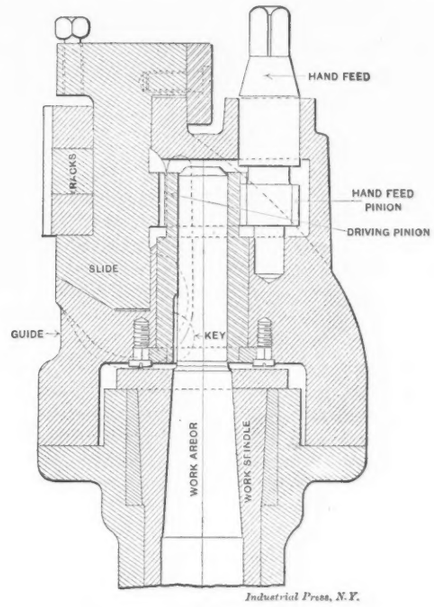


Fig. 7. Rack Cutting Attachment.

The head, Fig. 5, swings about the axis *x y* and is supported upon an extension of the sleeve *S*, which passes through the frame and extends about half-way into the head, which is bored to receive it. The head is shown in vertical section in Fig. 6. The cutter bar is balanced by the spring at the top, and on its upper end is the sleeve *B*, on which rack teeth are cut to mesh with teeth on segment *A*, keyed to shaft *O*. This shaft is driven by the crank motion, as before explained and gives the reciprocating motion to the cutter and cutter bar. The cutter bar is rotated by the worm *L* and worm-wheel *D*, which latter has a long hub bored out to receive the segmental casting *C*, which is fast to the cutter bar. The vertical edges of segment piece *C* bear against the vertical edges of an annular piece *E*, which fits inside the hub of worm-wheel *D* and is fastened to it. This construction is the same that was adopted some time ago by the Fellows Gear Shaper Company and has already been described in these columns. The object of the arrangement is to allow the bar to reciprocate within the worm-wheel and to receive its rotary motion from the worm-wheel through the contact of sliding surfaces sufficiently removed from the axis of the bar to make any wear of these sliding surfaces negligible in so far as it affects the rotary motion of the cutter.

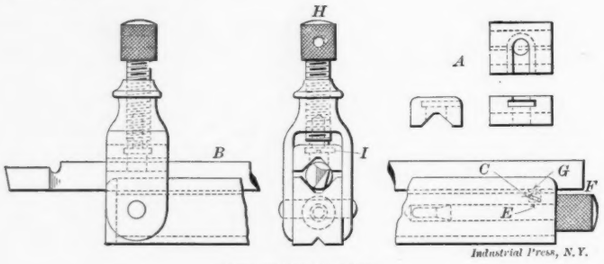
At *G* in Fig. 6 is the rotary cam which causes the head to rock about the center *O* for the relief of the cutter on the return stroke.

LETTERS UPON PRACTICAL SUBJECTS.

A HANDY BORING TOOL HOLDER.

Editor MACHINERY:

The writer would suggest a slight improvement in the boring tool holder shown in the August number of MACHINERY by Mr. E. H. R. In such a holder, where round tools are used, it is wise to place a shoe under the clamping screw and thus prevent the end of the latter from coming in contact with the tool. Such a shoe as is shown at *A* in the accompanying sketch will be found very satisfactory. This is slipped in place before the tool holder is assembled, the screw *I* being slid into the slot in the side and the screw driver being operated through the center hole. This screw should be a free fit in the shoe which it prevents from falling out and holds it always in its right place. This shoe should be cleared slightly in the center to insure its bearing properly at each end.



Boring Tool Holder.

The clamping post is arranged to swing on the pin connecting it with the body and when not in use as a tool holder, this post may be straightened out and the tool used for drill holder in connection with lathe work. With this holder the operator can feel the tension on the drill and is thus able to prevent many breakages. A hole drilled in the end of the shank carries a bar *F* which is used for tightening the binding screw. When not in use this bar is held in the shank by the pressure of the plunger *E* and spiral spring *C*, which is retained by a small screw *G*.

It often happens that one is required to bore a comparatively long and smooth hole for which no reamer is provided and, in such a case, the side tool *B* will be found to work very satisfactorily. It should be always set with the point leading slightly, as it is not the point but the side of the tool that is to do the cutting.

A. L. MONRAD.

New Haven, Conn.

"BABBITT METAL."

Editor MACHINERY:

In the November issue of MACHINERY is the quotation from *Metal Industry* claiming for Isaac Babbitt the invention of the idea of lining boxes and bearings with an antifriction metal, known as "Babbitt" metal, the patent of which was no doubt applied for and granted in good faith. My grandfather being identified with the Norris works in Philadelphia, and afterward with the mechanical department of the old "State road" at Parkesburg, Pa., was the inventor of a lining metal which he called "composition." At that time driving boxes (which were solid brass), engine trucks, and tender brasses, and crosshead gibs and rod brasses as they became worn, were refilled to their original size, with this "composition." My father being the brass molder at the Parkesburg shops, made and used the composition as required, in the locomotive repairs. As I became strong enough to go into the brass foundry, taking the place of an older brother, I mixed and used a great deal of the "composition." The ingredients were tin, copper, antimony. I don't know what the proportions of copper and antimony were, as my father always mixed it in a crucible and poured it into molds, convenient for breaking up. This mixture was called "hardening," and had a bright crystalline appearance at the broken surface. The composition was made by melting in an iron basin, four parts of block tin, and one part of the hardening. The tin was melted first. There was no patent on it that I am aware of. The mixture was a family secret, well kept. I did know at one time what were the proportions of copper and antimony, but have forgotten it. My father had been making and using this composition when I was in infancy, and I am now very near my sixty-seventh birthday. As I grew up to boyhood, and began to notice things, I often heard the old railroad men speak of the "old man's composition." Its wearing qualities were wonderful, and it would run cool, when applied to journal bearings.

W. DE SANNO.

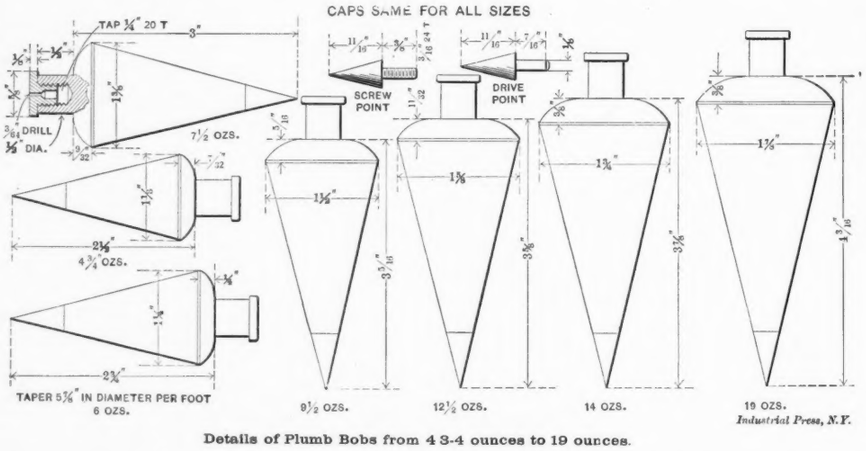
San Francisco, Cal.

DESIGN OF A MACHINIST'S PLUMB BOB.

Editor MACHINERY:

A fine plumb seems to be one of the instruments that is used in almost every trade as a kind of master instrument by which the work done by other tools is checked or proven, so that it is very natural that every mechanic should prize such an instrument. Of course there are many ways and styles in which these plumb bobs may be made, but those shown in the accompanying details will be found admirably suited for use on the better class of surveying instruments and for fine machine work in erecting and adjusting machine tools, engines and other things requiring to be accurately set.

The drawing shows seven sizes ranging in weight from 4¾ to 19 ounces. They should be made of cast brass or bronze or of bar brass, but in no case should cast-iron be employed, because at the present time the use of electricity is so common that a cast-iron plumb bob is often drawn out of its proper position by some local attraction. For this same reason the steel points are made comparatively small. The cap that screws into the head to receive the string or line should be knurled on the edges so as to be readily screwed in or out. The points, either drive or screw, should be made of machine steel and casehardened. These directions, with the detailed measurements given, should enable the machinist with very little trouble to construct a very handy plumb bob of almost any size that he is likely to wish.



Details of Plumb Bobs from 4 3-4 ounces to 19 ounces.

Burlington, Iowa.

F. W. SALMON.

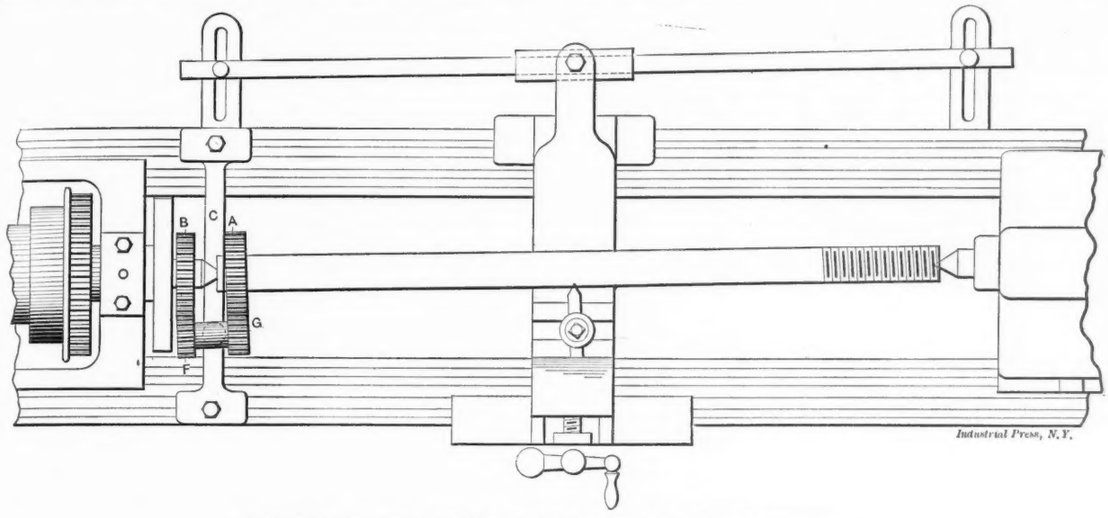
ACCURATE THREADING OF TAPS AND DIE HOBS.

Editor MACHINERY:

Experience in tap and die making has taught that it is one thing to make a perfect screw and quite another to make a tap which will perfectly correspond with it. It is well known that a tap shortens in tempering, this shrinkage varying some-

what with different grades of steel, so that a tap and a screw made with the same leadscrew will not correspond in pitch. Therefore to be accurate, allowance must be made in chasing the thread on the tap for the shrinkage that is to take place in the hardening.

To carry out this idea a little further: A hob and a tap may thus be made to correspond but after a die is hobbed and tempered it will not exactly match the hob or the tap which it is intended to suit. So we see that the hob should be made with an allowance of two shrinkages to counteract the shortening that takes place when it (the hob) is hardened and again when the die is hardened. While it is not the best policy to make taps and dies in the tool room it often becomes necessary to do so for sizes varying from the standard, and the problem then presents itself to cut them so as to make the proper allowance for shrinkage. The following method shows how the writer has accomplished this in a very satisfactory manner:



Method of Cutting Taps and Hobs with Allowance for Shrinkage in Hardening.

The change gears of the lathe are first arranged as usual for cutting the required number of threads per inch. The tailstock is then set over either way for a short distance and the taper attachment is set to correspond with the set-over of the tap. The thread is then cut as usual, the tool being set by the face of the tap. The thread cut in this way will be slightly coarser than would have been the case if the centers were in line with the axis of the lathe. The reason for this will be obvious from the illustration, and a little practice will enable the machinist to judge just how much the tailstock should be set over to obtain the required result. For example: If the tap is 10 inches long and is set over ½ inch, while the tool is moving the whole length of the tap, the movement of the carriage parallel to the axis of the lathe would be through a distance of but 9.987 inches, so that the thread is lengthened .013 inch; in other words, there are as many threads in 10 inches on the tap as would have been cut in 9.987 inches had the centers been in line with the shears.

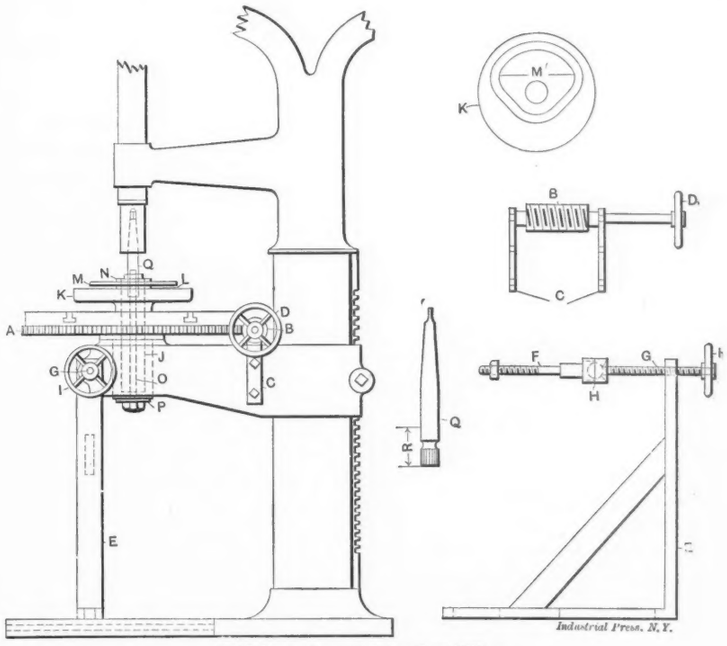
If now in cutting this tap we were to use an ordinary dog, driven from the faceplate, it will be apparent that the result would be a drunken thread, since the velocity of revolution of the tap would not be constant throughout its revolution but would be variable; so some means for driving is required that will transmit a uniform motion from the spindle to the tap. To accomplish this a small gear *A* is mounted upon the end of the tap, and a similar gear *B* is attached to the live center or to the faceplate. A fixture *C* is used for supporting a short shaft on each end of which is placed a pinion, as shown at *F* and *G*. These pinions are of the same size and engage with the gears *A* and *B*. When they are properly adjusted so as to run freely with these gears, they impart a perfectly uniform movement to the tap which is being chased. QUIRK.

CAM MILLING IN THE DRILL PRESS.

Editor MACHINERY:

Some years ago while building automatic machinery in a small shop connected with a manufacturing plant, the writer had occasion to cut a number of cast iron face cams, which were all different and varied in size from 6 to 14 inches in diameter. After an amount of consideration it was decided that we could cut these cams upon the drill press cheaper than we would be able to get them cut elsewhere.

The press available was of the ordinary upright type and to fit it for this work the plate was taken off and bored out to 1 15-16 inch. Then the lower edge of its periphery was turned to accommodate a strip of steel rack, *A*, ½ inch wide and about 14 pitch, which was procured from the stock of a gear manufacturing company. This rack was bent and fastened to the plate by screws passed through clearance holes in the rim of the plate and tapped into the rack. When this was in place it made a very good substitute for a worm wheel, and a piece of steel, *B*, was turned up and threaded to correspond with it. As the space between the post of the drill press and the plate was only 1¼ inch it was found necessary to place



Drill Press Arranged for Cam Milling.

the worm at a slight angle in order to give the thread as good a bearing as possible on the teeth of the rack. Two pieces of ½ x 1½ inch wrought iron, *C*, were cut and drilled to fit the reduced ends of the worm shaft, and these were then bolted on each side of the arm, supporting the plate in a position to allow the worm to mesh properly with the worm wheel. A handwheel, *D*, procured from an old valve, was fastened to the end of the worm shaft with a pin and this completed the rotary feeding mechanism.

The table and its supporting arm were free to swing around the post of the drill and were fed around by means of the mechanism shown at the right of the cut. The angle, *E*, had a long bolt, *G*, tapped into its upper end and the head of this bolt was turned to a ball shape which fitted easily in the socket, *H*. This socket was made in two parts and screwed into the hole previously occupied by the clamping bolt in the end of the supporting arm. The shank of this socket bolt was made a snug fit in the arm so that it would be rigid without interfering with the free rotation of the plate.

Upon a sheet of soft steel, 3-16 inch thick, the different cams were laid out and each carefully cut out to the exact size of the inside of the groove in the cam, as shown at *M* in the sample cam, *K*. As all of the cams were to be keyed to the same shaft, both cams and templets were bored to 1 15-16 inch, the exact position of the keyway being left to be determined by trial when the machine was assembled. A short piece of 1 15-16 inch shaft, *J*, which was a snug fit in the hole of the plate, was drilled to clearance for ¾-inch bolt, *O*, and a washer *P* was provided large enough to cover the hole at the bottom of the plate hub. The cam blanks were mounted, face upward, on the piece of shafting, then a collar, *L*, about ¼ inch thick was placed on the cam and above this the templet, *M*. A large washer, *N*, and the ¾-inch bolt then clamped the whole firmly to the plate.

For cutting the cams we made a right-hand end mill, *Q*, with a short length of the body the same size as the cutting edges, and hardened for a distance up the shank indicated by *R*. The shank of this cutter was made No. 3 Morse taper to fit the drill spindle socket.

The concentric portions of the groove were produced by simply turning the worm *B* by means of the hand wheel, and the rise and fall of the cam was produced by using both feeds simultaneously, keeping the body of the mill against the templet, the edges of which were moistened with oil. In order to make as little side thrust as possible the cams were cast with grooves, which allowed about 1-16 inch finish on each side, and they were thoroughly pickled to save the corners of the mill. The cams produced were equal to those made with more expensive and intricate mechanism, and having the templet at hand, it was a simple matter to replace any cam that became sufficiently worn to require it. F. W. A.

Philadelphia, Pa.

FIGURING A PAIR OF SPIRAL GEARS.

Editor MACHINERY:

Perhaps there has already been enough said about spiral gears without this sketch, but it contains an idea or two that appealed to the author as a little different from any seen before. It was desired to make a pair of spiral gears with a ratio of one to four and with pitch diameters about 2½ and 6 inches. Of course from the start we should not expect to obtain exactly these pitch diameters with spiral gears (although it might happen) any more than we would expect to get diameters 1½ to 6 with a 5 diametral pitch cutter and a ratio of 1 to 4 on spur gears.

The spiral gears are to be cut with a 6 diametral pitch cutter. As the diametral ratio of 2½ to 6 is the same as 1 to 2.4, this ratio must be taken into account in the total ratio of 1 to 4; therefore the angles of the teeth must be such that it will be the quotient of the ratio 1 to 4 divided by 1 to 2.4, or 4 to 2.4, which is equal to 1.666 to 1.

By constructing a triangle with 1.666 as one leg and 1 as the other then the hypothenuse will represent the angle of the teeth, where the acute angle adjacent the long leg is the angle of the larger gear, and the acute angle adjacent the short leg of the triangle is the angle of the smaller gear or pinion.

Thus we have the ratio of the angles of a triangle. The $\text{tangent} = \frac{\text{opposite side}}{\text{adjacent side}}$ or the tangent of the angle of the pinion is equal to 1.666, which is the tangent of 59 + degrees, and its complement 31— degrees for the angle of the teeth of the gear. These are only our trial angles. In the following equations let

$C.P$ = Circular pitch measured according to spur gears;
N = the number of teeth in a gear;
$P\ D$ = pitch diameter;
$\pi = 3.1416$;
Sec. = secant of angle of teeth with axes of gear.

Then $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$ on any spiral.

The corresponding circular pitch of a 6 diametral pitch cutter is equal to $\pi \div 6 = .5236$.

Transposing the first equation $N = \frac{P\ D \times \pi}{C\ P \times \text{sec.}}$ and substituting $\frac{6 \times 3.1416}{.5236 \times 1.166} = \frac{18.84}{.6105} = 30.85$ as the number of teeth.

We cannot have this number of teeth in the gear, and 31 would not be divisible by 4, as the ratio must be 1 to 4, so 32 and 8 must be taken as the required number of teeth in the gear and pinion respectively. This will increase the pitch diameter, but as eight teeth will make quite a small pinion, it was thought advisable to make it larger, rather than smaller, for although 28 and 7 could be taken just as well, this would make the total number of teeth 3½ smaller than the first result of 30.8 and 7.7, whereas 32 and 8 make the total only 1½ teeth larger.

The example up to this point can be worked in a very short time on the slide rule and save much work. Using the *C* and *D* scales take the approximate pitch diameters 6 and 2½, place 6 on the *C* scale opposite 2½ on the *D* scale, and over the left-hand index read 2.4 on the *C* scale. Place 2.4 on *C* scale over 4 on *D* scale, and over right-hand index read .6 on *C* scale. If the rule has a slot in both ends on the back, simply transfer the slide so that 6 on the *C* scale is over left-hand index of *D* and read 31 degrees nearly on the scale of tangents. If the rule has no slot in the left-hand end, invert the slide and over 6 on *D* scale read 31 degrees nearly on the scale of tangents.

In a trigonometrical table look up the secant of 31 degrees and find 1.166, and then find the corresponding circular pitch for 6 diametral pitch equal to .5236. Set left-hand index of *C* to 1.166 on *D*, and opposite .523 on *C* read .61 on *D*. Then place right-hand index of *C* opposite 6 on *D* and set runner to 3.14 on *C;* set .61 on *C* to runner, and under right-hand index of *C* read 30.9 as the number of teeth, which gives very nearly the same number as before. Using the first equation again: $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$ and transposing $\frac{C\,P \times N}{\pi \times P\,D} = \frac{1}{\text{sec.}}$ or $\frac{\pi \times P\,D}{C\,P \times N} = \text{sec.}$, substituting $\frac{3.1416 \times 6}{.5236 \times 32} = \frac{18.8496}{16.7552} = 1.125$, which is the secant of 27 degrees 16 minutes.

But in the above substitution the number of teeth was increased from 30.85 to 32 and the pitch diameter was not increased because we do not know how much to add, therefore we should expect that this angle would be too small. For the sum of the angles of the teeth with the axis of the gear and pinion should equal 90 degrees; therefore the angle of the teeth of the pinion will have to be found by the same formula as the gear.

$\frac{\pi \times P\,D}{C\,P \times N} = \text{sec.}$; substituting, $\frac{3.1416 \times 2\frac{1}{2}}{.5236 \times 8} = \frac{7.854}{4.1888} = 1.875$, which is the secant of 57 deg. 46 min. 27 deg. 15 min. plus 57 deg. 46 min. is equal to 85 deg. 02 min. This subtracted from 90 deg. = 4 deg. 58 min., which shows that the numerator of the fraction must be increased, therefore the pitch diameters 2½ and 6 must be increased, as the other factor is a constant.

The ratio we have found for the angles is 1 to 1.666, so we must increase the angles in this proportion. $1 + 1.666 = 2.666$.

4 deg. 58 min. = 298 min.

298 divided by 2.666 = 112 min.

$112 \times 1.666 = 186 +$ min.

112 min. = 1 deg. 52 min. This must be added to the angle of the gear, which was 27 deg. 16 min, making it now 29 deg. 8 min.

Also 186 min. = 3 deg. 6 min. and this added to 57 deg. 46 min. = 60 deg. 52 min. Taking the first equation once more and working to get the correct pitch diameters with these new angles, we have $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$; substituting $\frac{.5236 \times 1.1448 \times 32}{3.1416} = 6.105$, which is the pitch diameter of the gear of 32 teeth.

Also for the pinion $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$; substituting $\frac{.5236 \times 2.0541 \times 8}{3.1416} = 2.738$, which is the correct pitch diameter of the pinion of 8 teeth.

Therefore our example stands as follows:

6 diametral pitch cutter used.

	Pinion	Gear.
Number of teeth	8	32
Ratio of speed	4	1
Angles with axis	60 deg. 52 min.	29 deg. 8 min.
Pitch diameters	2.738 inches	6.105 inches

A relation for instance in a worm and worm gear, is that the pitch circumference of a worm gear divided by the ratio of the worm to gear, is equal to the lead of the worm. The same thing will hold true of a pair of spiral gears, for they are only modified worm gears. Therefore the pitch circumference of the large spiral gear, which is 19.1813 divided by the ratio 4, equals 4.7953. This should be the lead of the small spiral pinion. The lead of a spiral gear equals the pitch circumference divided by the tangent of the angle of the teeth. The pitch circumference of the pinion equals 8.6042; divide this by tangent of 60 deg. 52 min. = 1.79214, and we get the result 4.7955, which proves that the gears are correct.

E. M. WILLSON.

SOME SUGGESTIONS FOR DIE MAKING.

Editor MACHINERY:

In traveling around from one shop to another it is very interesting to the tool maker or die maker to note the different methods that are employed for the production of practically the same pieces of work. The writer remembers building, some time ago, the die shown in Fig. 2, which was designed by Mr. Thomas Gierding, of the New Haven Clock Company. This die performed five distinct operations before the piece shown in Fig. 1 dropped completed from the press. Recently in visiting a factory, I was somewhat amused to find three presses employing the services of three pressmen occupied in producing exactly the same piece.

In constructing this die it was not deemed practicable to make it of one solid piece since one small flaw would, in this case, spoil the entire die. A die block of machine steel was therefore used, having recesses counterbored for the insertion of tool steel bushings. These recesses were accurately spaced by the method illustrated in Fig. 3. One side and one end of the die block were machined perfectly square and a center line drawn lengthwise on the face of the block. The location of the recesses was approximately laid out with lead pencil and the recess *A* bored in the lathe, by strapping the block to the faceplate. Before loosening the straps by which the block was held, the parallels, *B* and *C*, were strapped to the faceplate bearing against the finished edges of the block. The straps holding the block were then loosened and the block moved along the strip *C* sufficiently to allow for the insertion of the spacing block, *D*, which had previously been made of the required size. The die block was then fastened and the hole *E* recessed. By repeating this operation, and adding a block each time until all of the recesses were bored, it was possible to space the die far more accurately than would have been possible by the time-honored method of laying it out with dividers. The punch holder and the stripper were then bored in the same manner, using the same spacing blocks.

The bushings *F*, *G*, *H*, *I*, *J*, *K*, were next made, and after being hardened they were lapped to size. The outside of the bushing was ground concentric with the hole by wringing the bushing on a piece of soft steel held in the chuck and turned to fit the hole in the bushing. The bushings were then forced in the die block and the die was completed. The punches were ground all over, to insure straightness, and they, in turn, were forced into the punch holder. The drawing and forming punches *L* and *M* were held with setscrews to prevent them from pulling out.

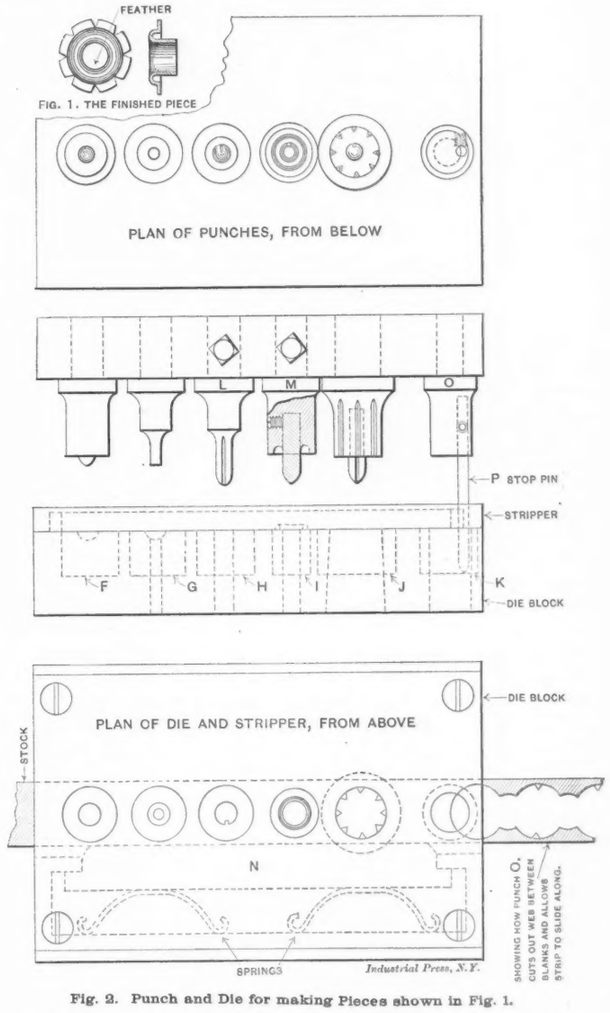
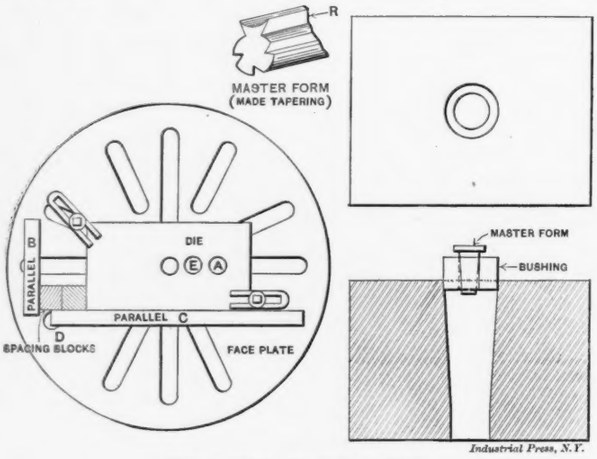


Fig. 2. Punch and Die for making Pieces shown in Fig. 1.

In using a die containing two or more punches, considerable trouble is sometimes experienced on account of the variation in width of the stock to be punched. Should the stripper be planed to fit one of the strips of stock very nicely the chances are that the next strip would not enter the stripper at all. The part, *N*, shown in the plan of the die, is a novel and practical way in which this trouble is overcome. The stripper is planed out 1-16 inch wider than the stock and recessed to allow the spring guide *N* to slide freely when the stripper is in position in the die. By glancing at the sketch the reader can readily see how the springs keep the stock pressing against the gage side of the stripper. The punch *O* does not perform any work pertaining to the finished blank but is used for cutting out the web in the stock in order to allow the strip to move along until the next web touches the stop pin. As the stop pin *P* does not come out of the stock it is therefore impossible to "jump" the stock and make a miscut, which would mean disaster to the drawing and forming punches.

After "setting up" the die in the press, the punches of course descend five times before a single finished piece ap-

pears but thereafter a finished piece drops at each stroke of the press. The first punch, beginning at the left, indents the stock and the punch is so adjusted that the face of the punch levels the stock. The second punch pierces the bottom of the indentation. The next punch draws the stock and at the same time forms the feather shown in the finished piece. The fourth is the forming punch and the last punch does the blanking.



Figs. 3 and 5. Die-making Kinks.

Fig. 4 shows a very good method of making a die that is to contain a number of identically-shaped teeth or points, such as dies for gear blanks, etc. While not being the most accurate method known, the writer considers that for all work intrusted to a punch and die the method illustrated will be sufficiently accurate. A set of broaches are made, as shown in the sketch, the number of steps being governed entirely by the length, or depth, of the teeth. The pilot fits the hole in the die, which is the diameter at the top of the teeth, and each step on the broach is .002 inch larger than the preceding step. The broaches are made on centers and necked in at *Q* to allow clearance for the chips. With a cutter of the proper shape the teeth are then milled on the broaches, using the dividing head on the miller. After cutting the teeth on all of the broaches the teeth on the punch should be cut at the same setting. The broach is then hardened and ground on the faces as indicated. In use each successive step is driven through the die until the last is reached, and this should be driven through as many times as there are teeth in the broach, turning it one tooth each time. By doing this whatever error may have been caused by hardening is overcome.

Fig. 5 shows a method for making very small, difficult-shaped dies, which are hard to duplicate when filed out by hand. First a master form is made, of the desired shape and tapering. This is carefully hardened. A hole is then

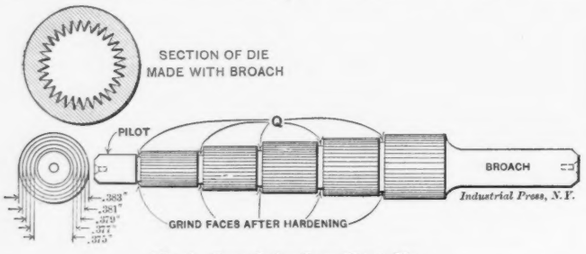


Fig. 4. Broach for Gear Blank Die.

drilled and reamed tapering, through a substantial block of tool steel, the block is hardened, and the hole lapped out perfectly smooth. A bushing of well annealed tool steel is then made, .005 inch smaller in diameter than the larger end of the tapered hole, and a hole drilled and reamed through it sufficiently large for the master form to just protrude through the lower end. The bushing containing the master form is then placed in the taper hole of the block and forced down by means of a hydraulic press. The stock is thus forced into the master form and dies made in this way can be easily duplicated when they are worn out.

Great Barrington, Mass. FRANK E. SHAILOR.

GLOBULES OR SHAVINGS.

Editor MACHINERY:

The December issue of MACHINERY gives an account of tests of emery wheels and carborundum wheels at Sibley College, where they micro-photographed the metal removed by the wheels and found that from the emery wheel to be in the form of globules, and that from the carborundum wheel to be in the form of shavings.

I very much doubt if the experimenters had before them all of the conditions to warrant conclusions, for the writer certainly has looked through the microscope and has seen shavings from emery wheels; he has also seen globules from emery wheels. The difference was caused by different treatment and by the difference in grades and grains of the wheel for the particular material ground.

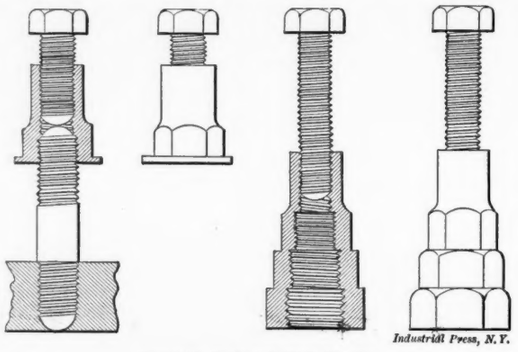
There are many things that enter in to change the results from all globules to part globules, and part shavings to all shavings. It is not so simple as would appear from the account. If the account is correct the experimenters have something to learn. C. H. NORTON.

* * *

THE STUD-DRIVER PATENTED.

We must confess to some irritation of mind upon seeing in *Engineering's* illustrated weekly patent record that our old shop friend, the stud-driver, was recently patented (September 23, 1903) in Great Britain by Mr. E. Ravet, of London. Mr. Ravet has our sympathy. The description reads as follows:

"The object of this invention is to provide an improved appliance affixable to a screw stud, and whereby the stud can be easily screwed into place. The apparatus comprises a screw nut of greater depth than usual, and the screwed part thereof is preferably of two diameters, one diameter of screw-threaded



Recently Patented Stud Driver.

hole encircling the stud, and the other for reception of a screw bolt, whose end engages the end of the stud, and on being tightened somewhat, tends to draw the nut toward it, and in so doing tightly clamps the nut to the screw thread of the stud, so that when the nut is operated by a spanner the stud will be turned without fear of slip. To release the appliance, all that is necessary is to turn back the lock-bolt, when the grip of the nut will be released, and the whole appliance be free to be removed by hand. The nut may have a tapering series of stud-holes of two, three, or more diameters, so as to be applicable for various sizes of studs."

* * *

RE HISTORY JOHN STEPTOE SHAPER CO.

Editor MACHINERY:

In your article "Old Gear Cutter—History John Steptoe Shaper Co.," the Mr. Ed. Gang mentioned is Mr. William E. Gang, president of the William E. Gang Company. He is generally known among his friends and associates as "Ed." He is proud of the fact that he served his apprenticeship in John Steptoe's shop.

ARTHUR H. GANG,
Cincinnati, Ohio. Secretary William E. Gang Co.

* * *

A plate mill has recently been erected at Coatesville, Pa., which is said to roll the widest plates made in this country. It will roll boiler plates 12 feet wide and up to ⅞-inch thickness. The rolls are 152 inches long.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

TWENTY-EIGHT INCH "AMERICAN" SHAPER WITH SPEED VARIATOR.

The 28-inch shaper illustrated in the half-tone herewith has just been placed on the market by the American Tool Works Co., Cincinnati, Ohio, and while the machine in general follows the design of their regular line of shapers, it has several new features, the principal of which is the speed variator, which takes the place of the cone pulley used with the ordinary type of machine. This shaper, as shown, is motor-driven and can be used with any type of motor, of constant or variable speed, single or multiple voltage. The motor is mounted at the rear on a base cast integral with that of the machine and may be connected to the speed variator by either gearing or flexible chain. The changes of speed are obtained through the variator, while the shaper is in full operation, by a clutch mechanism operated by conveniently-located levers, and the number of speeds thus obtained is doubled by means of the back gears. The necessary adjustment for speed is determined by reference to an index on the gear box.

The stroke of the ram is positive and its length may be changed at will without stopping the machine. The rocker-arm is pivoted near the base line, giving the ram an almost uniform rate of speed throughout its entire stroke and providing a quick return. The cross feed is variable and automatic, with a wide range of feeds, and readily adjusts itself to any elevation of the rail. A reversal of the feeds is readily accomplished while the machine is in operation. This shaper is also suited to belt drive from a countershaft through a single pulley mounted on an extension of the upper shaft in the gear box, and the flexibility of this construction makes it a simple matter to equip a shaper that has been installed as a belt-driven machine, with motor drive at any time.

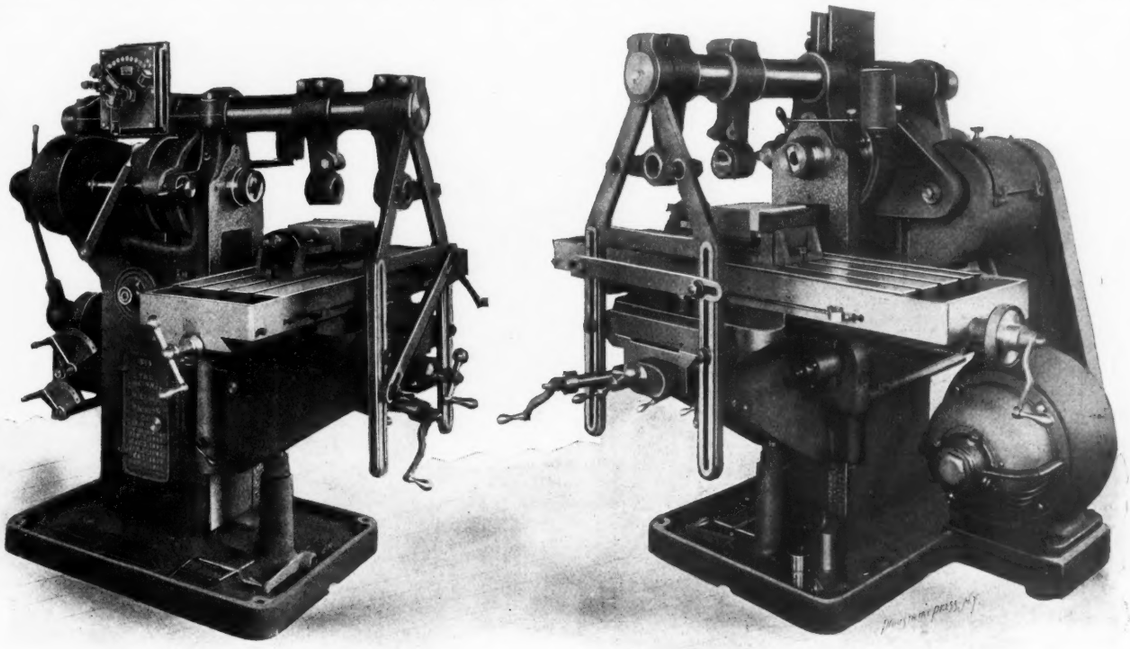
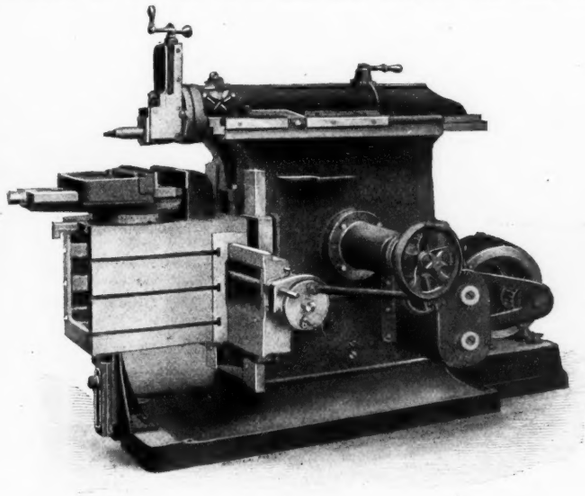


Fig 1. Cincinnati Milling Machine with Electric Motor Drive.



Twenty-eight inch "American" Shaper with Speed Variator.

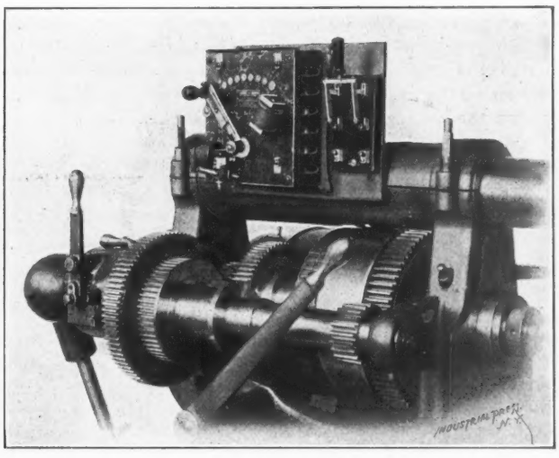


Fig. 2. Double Back Gears of Cincinnati Milling Machine.

ELECTRICALLY-DRIVEN MILLING MACHINE.

As the result of about four years' careful experiment and study of the problem of electric driving as applied to milling machines the Cincinnati Milling Machine Co., Cincinnati, Ohio, have just brought out the No. 4 plain miller with motor drive, that is illustrated in the photograph, Fig. 1. This machine is designed to be driven by a shunt-wound, direct-current motor operated by a field rheostat, the variations in

speed being obtained from the motor and thus obviating the need of a nest of speed change gears. The right hand view of the machine shows how the motor is mounted on an extension cast onto the base. This brings it near the floor, thereby adding stability to the machine.

Any one of several well known makes of motors may be used provided it is shunt wound for a speed variation of 2½ to 1. This is multiplied by the double back gears so as to give a range of spindle speeds for cutters 5-16 to 6 inches in diameter of 20 feet per minute, and for cutters ⅝ to 12 inches in diameter of 40 feet per minute. Power is transmitted from the motor to a friction clutch and from thence to the spindle by Morse silent chains. This interposition of the friction clutch between the motor and the spindle is one of the novel features of the design. By its means the machine may be started and stopped quickly without stopping the motor, thereby saving considerable time that is otherwise lost in starting and waiting for the motor to stop.

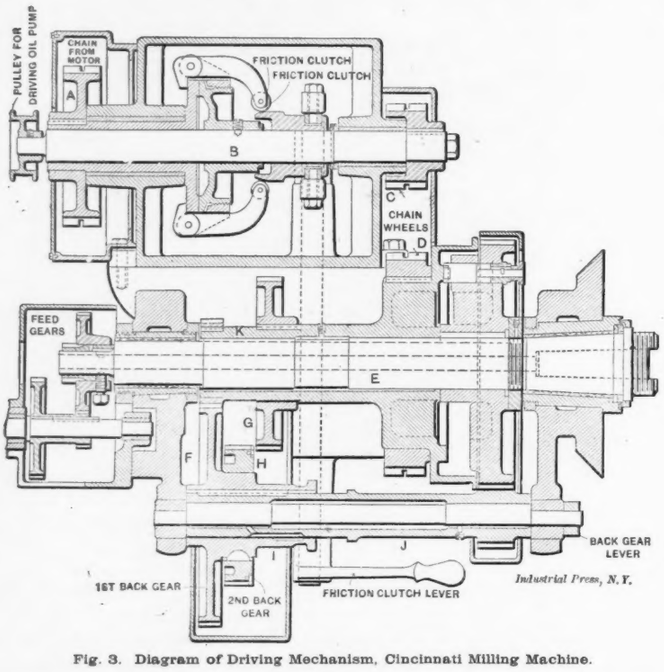
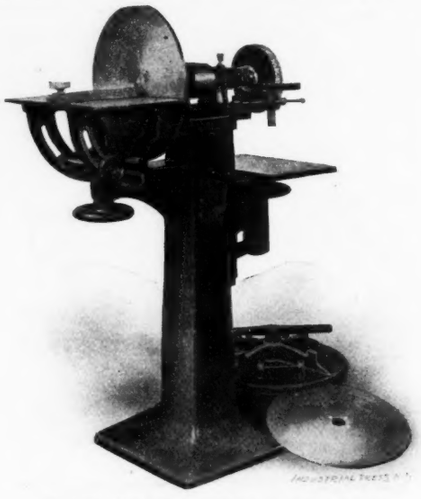


Fig. 3. Diagram of Driving Mechanism, Cincinnati Milling Machine.

The left hand view shows the arrangement of the automatic release, starting box, field rheostat, friction clutch lever, back gear lever, and double back gears, as well as the feed changing and adjusting levers, all of which are placed at the front of the machine, within easy reach of the operator, who need never go to the rear of the machine save for oiling it. Fig. 2 shows the arrangement of the double back gears, the details of construction of which are shown in the drawing, Fig. 3. The chain from the motor drives the wheel, *A*, which transmits power through shaft *B* and chain and chain wheels, *C* and *D*, to spindle, *E*. The back gears, *F* and *H*, are both geared to a sleeve, *I*, which slides on the back gear quill, *J*, and when used in the position shown, gear *F* is driven by the small gear on the main driving quill, *K*, giving the first series or slow back gear speeds. When it is desired to use the second back gears, the gears are thrown out of mesh in the usual way, the sleeve is moved along the back gear quill to bring *H* and *G* in line and the gears thrown in again.

SANDING MACHINE AND TOOL GRINDER.

A machine designed especially for the use of patternmakers and woodworkers is the combination sanding machine and tool grinder which is illustrated herewith. On the left-hand end of the spindle is mounted a steel disk 16 inches in diameter, which is covered with sandpaper on both sides and is easily reversed. This is used for sanding surfaces at right angles, or at any angle with the plane of the disk, and is very serviceable for turning bosses, core prints, etc., either straight or tapered, which can be done in the time usually required to set up such work in a lathe. A spare disk is also provided so that no time need be lost, as



Combined Sanding Machine and Tool Grinder.

one disk can be prepared while the other is in use. The sandpaper is attached to the disks, under pressure, in a press that accompanies the machine.

The work table, which is counterbalanced, is released, raised or lowered, adjusted to approximate position, and fastened by one lever and then by a hand wheel under the table, a fine adjustment or screw feed is provided. This table will lock at a right angle to the disk, or will adjust to any angle, and is furnished with a gage adjusted to any angle on the horizontal plane.

On the right-hand end of the spindle is placed an emery wheel for tool grinding and, by changing wheels, all shapes of tools, gouges and carving tools can be ground inside and outside. Under this wheel is a table for surface grinding, which is very handy for use on metal patterns and work of a similar nature. The bearings, which are babbitted and dust-proof, are provided with an adjustment for wear. This machine is the product of the Rowbottom Machine Co., Inc., Waterbury, Conn.

THE "IDEAL" ENGINE LATHE WITH MOTOR DRIVE.

The photograph shown in Fig. 1 illustrates the method by which the Springfield Machine Tool Company, Springfield, Ohio,

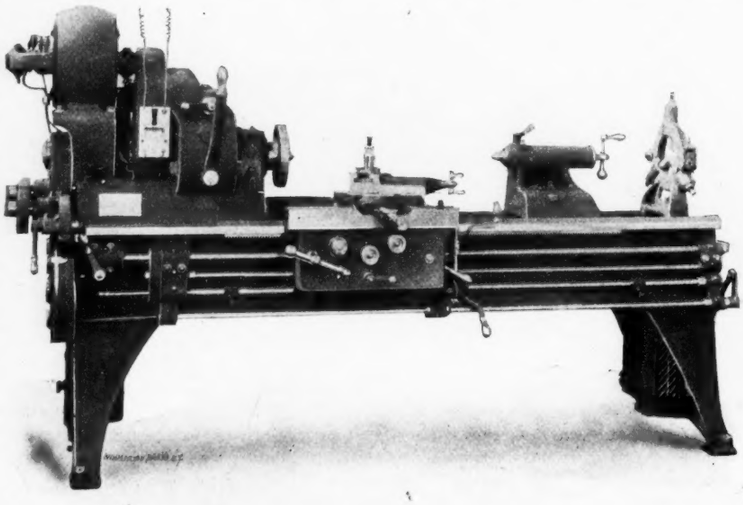


Fig. 1. "Ideal" Engine Lathe with Motor Drive.

have equipped their 18-inch "Ideal" engine lathe for the use of motor drive. As will be seen in the illustration, this lathe has been completely redesigned as a motor tool so that, instead of bolting a motor-bracket to the headstock, projections for carrying the motor and also bearings for the extra shaft are cast integral with the headstock. The details of the driving mechanism are clearly shown in the line drawing, Fig. 2, which represents a section through the headstock. A pinion on the motor shaft engages a gear on the extra shaft which is mounted directly over the lathe spindle. On this shaft are placed a pair of gears which may be slipped into mesh with either of the gears which take the place of the usual cone

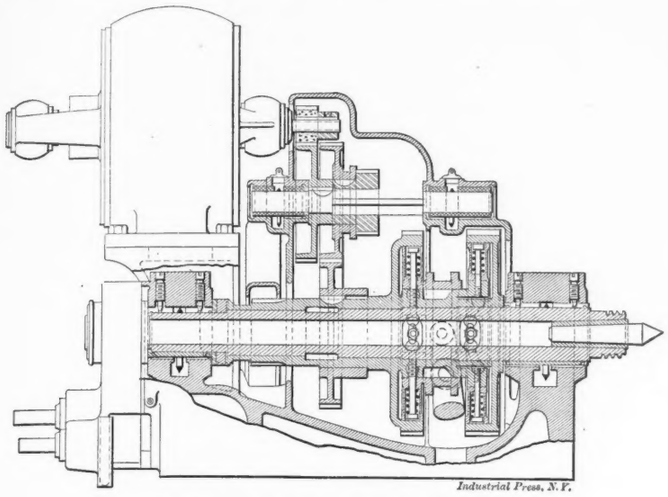


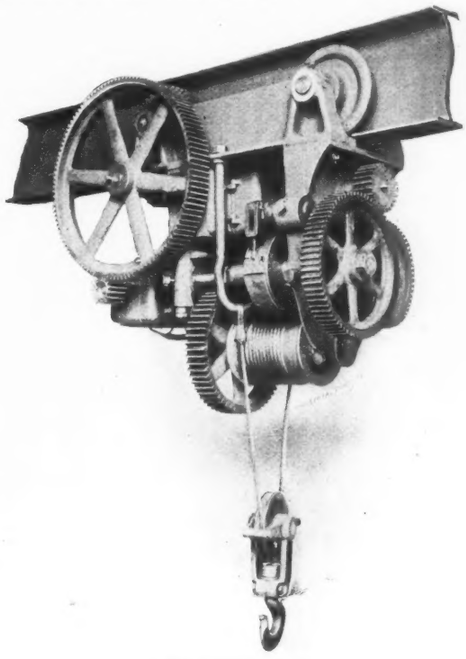
Fig. 2. Section through Head of "Ideal" Lathe.

pulley. In connection with the back gears, which are thrown in and out by means of a pair of friction clutches, four mechanical changes of speed are obtained, and these, with the 100 per cent. of speed variation of the motor, provide for a wide range of speeds.

The motor employed is a 1½ horse power machine built by the Northern Electric Manufacturing Company, Madison, Wis., and runs at a normal speed of 600 revolutions per minute, which may be increased to 1,200 revolutions by weakening the fields. The speed of the motor is regulated by a Cutler-Hammer controller, which is bolted to the inner side of the rear leg of the lathe, where it is protected from injury yet easily accessible if repairs are necessary. The rod by which the controller is operated is supported in extensions to the leadscrew box, while a handle at the right-hand side of the carriage operates the controller rod by the means of miter gears. In other respects this lathe embodies all of the principal features of the "Ideal" lathe as built by the company.

ELECTRIC TROLLEY HOISTS.

The use of small cranes or hoists, running on overhead I-beams, has widely extended in machine shops and at present the majority of heavy tools are provided with some type of hoist for quickly and easily handling the work on and off from the machine. These hoists may be operated by hand, steam, compressed air, or electricity, the latter power having proved very satisfactory and convenient since it does away with all the piping that is involved by the use of air or steam. A new line of this type of hoist, operated by electricity has just been brought out by the Northern Engineering Works, Detroit, Mich., and one of them is illustrated herewith. This hoist is of the two-motor type and has a capacity of 3 tons. It is spur-geared throughout and has a hoisting speed of from 10 to 25 feet per minute, the hoist being operated by a 3 horse power motor. The travel movement is operated by a separate motor of 2 horse power capacity which is capable of giving a travel speed of about 200 feet per minute. Two automatic brakes are provided, one mechanical and one electrical, and a safety stop prevents the block from running into the trolley. This hoist can be made to run on any size of I-beam or on two beams if preferred, and it may be modified so that it will run around curves if desired. These hoists are made in capacities of 2, 3 and 5 tons, and the motors may be wound to run on 110, 220 or 500 volts, direct current. The motors are of the enclosed type and are adapted for use in the presence of considerable dust and dirt and when so used the gears are provided with casings.



Electric Trolley Hoist.

POSITIVE SELF FEED FOR THE DRILL PRESS.

The W. F. & John Barnes Co., Rockford, Ill., have just adopted for use on their entire line of upright drills a new positive self-feeding mechanism which is a radical departure from anything yet produced for this purpose. Fig. 1 shows

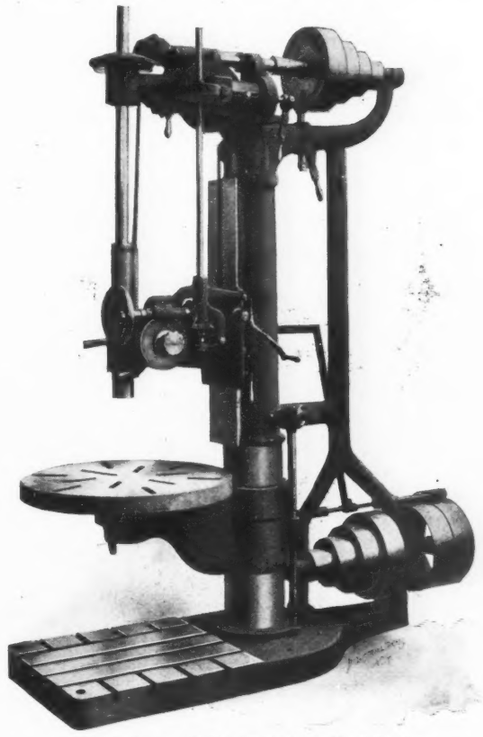


Fig. 1. Barnes Drill with Positive Feed Device.

one of the drills thus equipped and Fig. 2 is a detail of the feeding mechanism, showing the back gearing and the feed-changing device. The vertical feed rod is driven from a feed disk having four series of teeth, with any one of which the

driving pinion on the horizontal shaft may be engaged. A notched lever is employed to move this pinion and to lock it in position and when this lever is raised the pinion may be moved from the position shown in the illustration to engagement with any other set of teeth in the disk. This provides for four changes of feed and, with the back gearing used on the

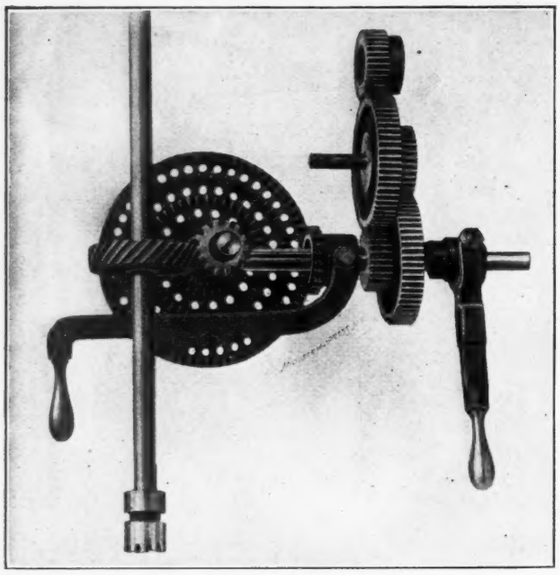


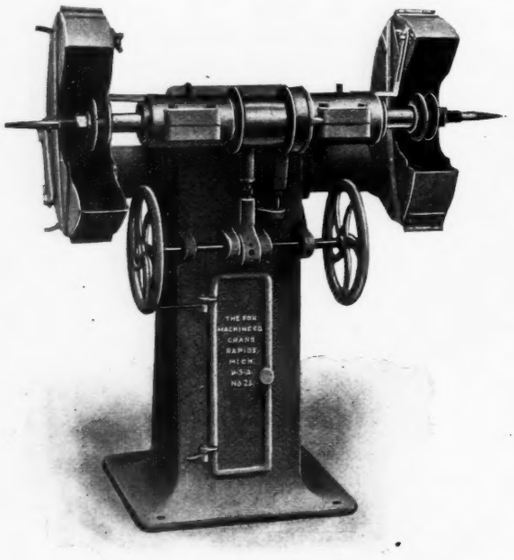
Fig. 2. Positive Feed Device used on Barnes Drills.

larger sizes of drills, eight changes of feed may be obtained, and these changes may be made while the drill is in operation, thus avoiding the delay of stopping the machine for throwing in or out of belts. These feeds are arranged to vary from one adapted to reamer work, or one for drilling in steel, to one of suitable coarseness for boring in cast iron. The wide variation of feeds also fits these drills for use with both the regular grades of steel and with the high-speed steels that are now being used very extensively.

DOUBLE POLISHING STAND.

The Fox Machine Co., Grand Rapids, Mich., have just brought out a new polishing stand embodying several novel and very convenient features that fit it for rapid work and clean service. The polishing spindle of this machine, instead of being carried directly by the column, is supported in a swinging yoke which is pivoted about the top of the column, as will be clearly seen in the end view of the machine. This yoke is connected, through a right- and left-hand connection, to an eccentric shaft journaled in brackets on the face of the column. On either end of this shaft is placed a large hand wheel so that the polisher may be started or stopped by either operator from his position in front of the machine. A partial turn of either of these wheels in one direction tightens the belt and causes the spindle to rotate, while if the wheel is turned in the other direction the arm is raised and the belt thereby loosened while at the same time a brake is automatically brought into action so that the machine is instantly stopped.

These polishers are designed for use with an exhaust system and for this purpose both of the wheels are covered with dust hoods or collectors, which have exhaust connection with the hollow column. The columns themselves may be connected with the exhaust system either from the back or down through the column and the floor. By this system all of the dust and dirt of polishing is immediately removed, a feature which is especially valuable where gold and silver are being polished, as in jewelry shops, where the dust is conducted to a precipitating tank and all of the valuable metal recovered. The hoods may be adjusted to accommodate different sizes of wheels from the maximum of 14 inches in diameter down, and they are bolted to the column in such a manner that they may be readily detached if desired. The arbor runs in roller bearings which are thoroughly protected from dust and dirt. No special countershaft is required, as the yoke acts as a belt tightener and the flanges of the pulley prevent the belt from running off. The machine complete weighs about 450 pounds.



Double Polishing Stand.

ELECTRICALLY-DRIVEN TOOL ROOM DRILL.

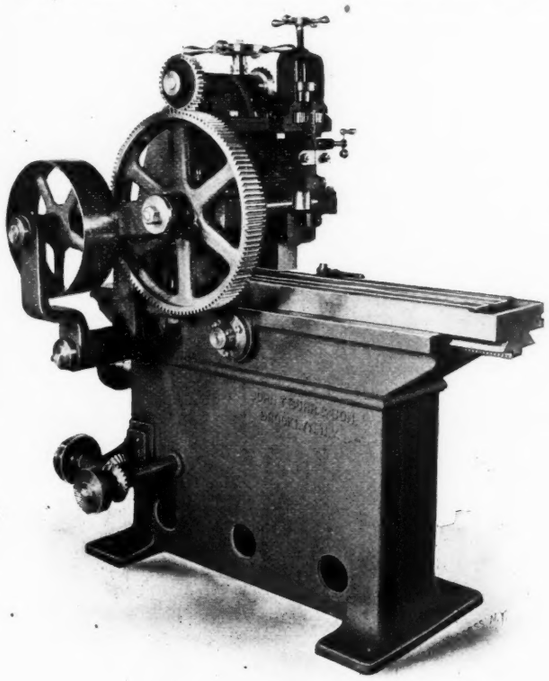
An application of electric drive to small drills has lately been brought out in the form illustrated herewith, which is a tool room drill built by the Dwight Slate Machine Co., Hartford, Conn., to the spindle of which is directly connected a one-quarter horse power motor made by the Emerson Electric Mfg. Co., St. Louis, Mo. Owing to the specially compounded and series field, the motor employed is connected directly from line to binding posts without starting box, being started and stopped from a small two-pole snap switch within convenient reach of the operator. The rush of starting current is cared for by the speed regulating coils of the motor itself, and the proportions of this field are such that if the motor should be stopped entirely by the drill sticking in the work, or by the use of too large a drill, no damage to the motor would result. This special winding also enables

Electric Tool Room Drill.

the motor to automatically adjust its speed to the size of the drill in the chuck and the material being drilled, this regulation being obtained by the motor itself entirely automatically. The motor furnished will handle work up to the full capacity of the drill press, being capable of running a 5/8-inch drill in cast iron, but it is not recommended for drills much over 5-16 inch for general use. This machine may be placed and operated anywhere that a 110 or 220-volt direct current is available.

KEYSEAT MILLING MACHINE.

The accompanying half-tone illustrates a new keyseat milling machine that has just been placed upon the market by John T. Burr & Son, Brooklyn, N. Y., which is designed for keyseating shafts up to 6 inches in diameter, and which has an extreme capacity through the housings for work up to 10⅜ by 9⅜ inches. The platen, provided with three T-slots, oil channels and pockets, has an automatic feed of 48 inches with automatic adjustable tripping device. The spindle is designed for cutters with 1½-inch standard hole, up to 5 inches in diameter, and this spindle has an adjustment allowing it to work at a distance of 1⅛ inches above the platen up to a



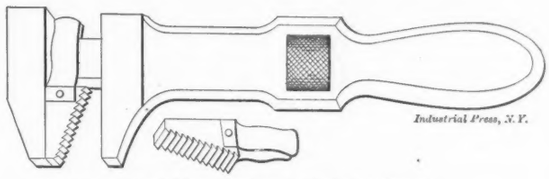
Keyseat Milling Machine.

maximum height of 11½ inches. The friction countershaft provides for two changes of spindle speed and there are twelve changes of feed for each spindle speed.

Connected with the main driving gears is a chain of gearing by means of which an independent routing spindle is operated. This spindle has an independent vertical adjustment of 3¼ inches and a horizontal movement of 3⅛ inches, while, in connection with the saddle movement, it may be used at a height from the face of the platen up to 13⅜ inches above it. An oil pump with flexible connections is provided for the use of lubricant with the cutters. This machine complete, as shown, weighs about 3,200 pounds, and it may be furnished without the routing spindle if desired.

PIPE ATTACHMENT FOR WRENCH.

The Billings & Spencer Company, Hartford, Conn., have just placed upon the market an attachment for use with their 6- and 8-inch adjustable wrenches, by means of which the ordinary wrench is immediately converted into a pipe wrench. This attachment consists of the small removable pipe jaw which is shown in the cut both in position on the wrench and also as it appears when it is removed. This jaw is made of steel, provided with a toothed face for gripping the pipe and is held in place by two side springs which allow it to be put in place or removed without any trouble or the need of any tools. By simply reversing its position on the wrench, it is

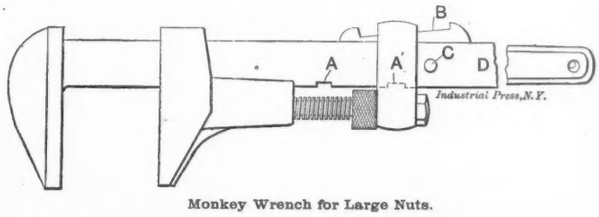


Adjustable Wrench with Pipe Attachment.

fitted for either right or left hand use. The wrenches, when supplied with this attachment, are suited for use on pipe up to and including ¾-inch.

IMPROVED MONKEY WRENCH FOR LARGE NUTS.

That indefatigable inventor and improver of the monkey wrench, Mr. Loring Coes, evidently has again been engaged in his favorite amusement, since the Coes Wrench Company have recently brought out an improved form of this useful tool, designed to be of greater service in heavy work. The new style, shown in the accompanying cut, is made in two sizes, viz.: 26-inch and 30-inch for nuts up to 5 and 6 inches respectively. The improvement consists of making the handle

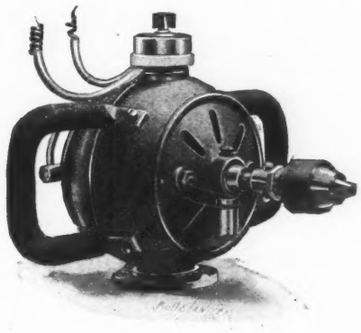


Monkey Wrench for Large Nuts.

in the shape of a flat iron bar and notching it in two places, *A* and *A'*, for the reception of a projection on the inside of the strap next the bolster. Obviously the strap is placed in position *A* for the smaller nuts and at *A'* for the larger ones, this device doing away with an excessively long screw. In either position the strap is firmly held by the double-headed key *B*. A pin *C* through the handle *D* prevents the strap sliding off when the change is being made.

SMALL PORTABLE ELECTRIC DRILL.

The Sprague Electric Company, New York City, have just placed on the market two sizes of the small portable drill that is shown in the accompanying illustration. This type of drill will be found very handy for all kinds of shop drilling which is now performed with the breast drill, and saves much time and labor in the erection of machinery where small holes, such as oil and pin holes, are drilled after the machines are



Portable Electric Drill.

assembled. A small round type of motor is employed, which is suited for use on a 115 or 230-volt direct current, and two substantial handles are attached to its sides to hold it while in use. The motor shaft is fitted with a standard adjustable chuck for any size of drill up to and including 5-16 inch. The two sizes that are now being furnished are of a capacity of 1-20 and 1-10 horse power respectively.

NEW TRADE LITERATURE.

THE STOW FLEXIBLE SHAFT COMPANY, Philadelphia, Pa. Circular calling attention to the portable drills of the company's manufacture. Several varieties of these are here shown.

THE WILLIAM E. GANG COMPANY, Cincinnati, O. Pamphlet illustrating and describing the radial drill manufactured by this company. This was illustrated in MACHINERY some time ago.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y. Two new circulars relative to the "Buffalo" disk wheels and "Buffalo" improved ventilators. These are illustrated, and the two named products are described quite at length.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis. Bulletin No. 34 illustrating their motors for operating valves. These motors are built for operating large sluice and gate valves, and are here fully described.

THE CARLYLE JOHNSON MACHINE COMPANY, Hartford, Conn. "Booklet C," treating of the Johnson friction clutches for machines, gas engines, countershafts. Also circulars illustrating and describing their No. 4 and No. 6 single clutch.

THE BINSSE MACHINE COMPANY, Newark, N. J. Catalogue and Treatise No. 3, 1904. This illustrates the "Binsse" horizontal boring machine, sizes 1, 3, 5 and 9, and gives brief descriptions and fine half-tone views of its various features and of work done.

THE KEMPSMITH MANUFACTURING COMPANY, Milwaukee, Wis. Advertising card illustrating their No. 24 universal miller, among whose features are automatic feeds in all directions; feed reverse at front of knee; telescopic vertical screw and deep and broad column.

THE NEWTON MACHINE TOOL WORKS, INC., Philadelphia, Pa. Catalogue No. 37, of rotary planers. These are built in eleven sizes, with heads from 14 inches to 84 inches in diameter over tools, and several styles are shown such as the rotary planer on round base, the portable rotary planer, duplex rotary planer, vertical rotary planer, etc.

THE ARMSTRONG BROTHERS TOOL COMPANY, Chicago, Ill. Catalogue No. 10, of tool holders and machine shop specialties. The new goods added to their regular line are: A drop head tool holder; left-hand offset cutting-off tool; side tools; a slotter tool; a universal ratchet drill; and a machine for cutting off self-hardening steel.

THE WOODWARD & POWELL PLANER COMPANY, Worcester, Mass. Catalogue B4, of metal planing machines. This illustrates the company's planers, 22 to 120 inches; widened planers from 36 by 30 inches to 76 by 48 inches; and special planers, for work on globe valves, frog crossings, locomotive rods, etc. Several half-tone views show the works at Worcester, and interior views of the business offices, the various departments, etc.

THE FOSDICK MACHINE TOOL COMPANY, Cincinnati, O. Handsomely illustrated folder treating of the new Fosdick horizontal, boring, drilling and milling machine. A general description of this machine appears, and excellent photographic reproductions showing the operations of boring, drilling and milling, also cuts reproducing the working drawings of the plan, side elevation and front elevation of the machine.

THE NORTHERN ENGINEERING WORKS, Detroit, Mich. Catalogue No. 18, of electric and hand power traveling cranes. This supplements the company's general crane catalogue and illustrates their cranes for pumping stations, power stations for electric railways, large industrial plants and lighting stations. Besides these they also manufacture cranes for foundries, machine shops, etc. A number of views show these cranes installed in different shops.

THE CURTIS & CO. MFG. CO., St. Louis, Mo. Illustrated catalogue, 1904, of pneumatic machinery. This includes air compressors, air hoists and pneumatic appliances. The "Curtis" automatic compressor, belt-diven and electrically-driven is shown by half-tones and line drawings; and air hoists of different sizes and styles for many and various purposes. Also "Curtis" single and double I-beam traveling cranes and trolleys and other hoisting apparatus. A number of views show these hoists, cranes and trolleys installed in foundries, shops, etc.

THE BRADFORD MACHINE TOOL COMPANY, Cincinnati, O. Illustrated catalogue, standard size, of the "Bradford" lathes. This is an attractive piece of advertising literature, containing handsome half-tone illustrations, printed on heavy coated paper, showing the different sizes of lathes, and its notable features, such as the spindle and its mountings; spindle bearings; lathe apron; improved taper-turning attachment; lathe parts; turning tools; chucks; screw-cutting attachment; the driving and feeding arrangement for their 36 and 42-inch lathes, etc.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, O., inform us that their Shop No. 2 of their plant, containing punch presses, annealing ovens and forges, was recently partially destroyed by fire. Their tools are not seriously damaged, however, and they have erected temporary sheds over them, so that there will be no delay whatever in completion of orders they have on hand or of any they may receive. Shop No. 2 will be immediately reconstructed and on a larger scale than originally planned.

THE F. B. SHUSTER COMPANY, New Haven, Conn. New illustrated catalogue of straightening, cutting and riveting machinery. This includes automatic wire-straighteners and cutters; slide feed, automatic wire-straighteners and cutters; roll wire-straighteners; self-feeding roll wire-straighteners; geared roll straightener and cutter; rotary straighteners; elastic rotary-blow riveting machines; double-head riveting machines, etc. Views of these machines are shown, and samples of the work done. The company will be pleased to supply this new catalogue on request.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I. Latest edition of the company's machinists' tool catalogue. Here are illustrated and described their regular line of machinists' tools; and a colored insert calls attention to the various new tools that have been added during the past year, among which is the new clamping device for their micrometer caliper, which they inform us is entirely new in design and much superior to the old-style clamp nut. The catalogue contains 153 pages, some of which are devoted to tables and other data of convenience to the machinist.

THE HYATT ROLLER BEARING COMPANY, Harrison, N. J. Bulletin Twenty, of the Hyatt flexible roller bearings. This roller is here thoroughly treated, illustrations being given showing its application to shafting, traveling cranes, transfer cars, trolleys, hoists, etc. The advantages claimed for these bearings are durability, practicability, simplicity, efficiency, low cost, oiling facilities, and the fact that they have been thoroughly tested and have proved successful. The company refer those desiring further information upon this subject to an account of a series of exhaustive tests of these bearings conducted by the Franklin Institute and published in their Journal, February, 1899.

AMERICAN SCHOOL OF CORRESPONDENCE, Armour Institute, Chicago, Ill. Folder relative to the "Cyclopedia of Engineering." This is a compilation of the most practical and instructive papers of the School, intended to furnish actual instruction to those who cannot take a correspondence course. It has been carefully prepared with a view to meeting actual shop needs and conditions. It consists of four volumes and comprises 2,500 pages, illustrated with 1,500 colored plates, diagrams, tables, formulas, etc., and treats of mechanical, electrical, stationary, marine and locomotive engineering, etc. The folder gives an outline of the contents of this work, which is edited by Prof. Louis Derr, of Massachusetts Institute of Technology.

THE CHARTER GAS ENGINE CO., 9-11 Wallace St., Sterling, Ill. Catalogue P, just issued, of the "Charter" gas and gasoline engines. The special features of this engine are here described and illustrated, and the different styles of horizontal engines, for a great variety of purposes, and built in sizes of from 4 to 40 H. P. are shown. A 1½ H. P. vertical "Charter" engine appears, also cuts and description of the "Sterling" portable gasoline engine of from 8 to 25 H. P. capacity. Several circulars have likewise been received from the Charter Gas Engine Co., containing testimonial letters from a very large number of firms in every line of trade in which these engines may be used, speaking in very favorable terms of the "Charter" engines.

HAMMACHER, SCHLEMMER & CO., New York. Booklet entitled "Fifty-five Years at It," calling attention to the large line of articles the company manufacture, and to the fact that they issue yearly 3,000 pages of catalogue matter pertaining to this line. This literature is supplied gratuitously to manufacturers having worthy commercial ratings, and on fair terms, to individuals desiring same. Those having no printed letter head are requested to announce what their requirements are. Mention is made of Catalogues No. 180, presenting 908 pages concerning tools; No. 114, relative to bolts, screws, nuts and supplies; No. 145, builders' hardware; No. 151, cabinet hardware; No. 192, fancy cabinet trimmings; No. 170, tool outfits for home use, etc.

MANUFACTURERS' NOTES.

MARIS BROS., makers of hand and electric power cranes, Philadelphia, Pa., are building a 30-foot addition to their works. They report business as good.

THE COCHRANE-BLY MACHINE WORKS, Rochester, N. Y., have recently moved into their new factory, corner of Sherman Street and St. James Park. The new shop is very substantially built and is 40 feet by 200.

THE HOWARD IRON WORKS, Buffalo, N. Y., manufacturers of elevators, vises, bolt machinery and power transmission machinery, inform us that they are just completing a new and large modern foundry, with all the improved equipment necessary.

THE J. W. CREGAR AGENCY, The Bourse, Philadelphia, Pa., have been made purchasing agent for the Limon and Agricola Mines, near Jalapa, Nicaragua, Central America, and would be glad to have manufacturers send their catalogues and export trade prices on everything used in mines and sold in mining companies' stores.

THE HOMESTEAD VALVE MANUFACTURING COMPANY, Pittsburg, Pa., announce that in conjunction with their brass foundry they have installed a complete iron foundry for the production of brass and iron. They inform us that through their method of using a conversion furnace in which heavy blast is used, they obtain a very pure metal, which enables them to make a superior semi-steel valve.

THE DERRY-COLLARD COMPANY, 256 Broadway, New York, are publishing a series of "Monographs on Popular Technical Subjects." We have already noticed in these columns the two booklets treating of Turning Tapers and of the Drafting of Cams. Two more have since appeared: Commutators, and Threads and Thread Cutting, and others are in course of preparation. The price of each monograph is 25 cents.

THE HARTFORD BLOWER COMPANY, Hartford, Conn., have received an order for furnishing exhaust systems for the buffing and plating departments of the N. Y., N. H. & H. R. R. Co., at their new shops at Readville, Mass. The apparatus consists of two special, direct-connected, motor-driven "Hartford" adjustable exhaust fans, "Hartford" patent improved dust collectors, galvanized sheet steel piping, hoods, etc., with many new special fittings and attachments.

THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., have sent us a duplicate of a letter they recently received from the Norcross Brownstone Company in regard to their Cling-Surface preparation. It speaks most favorably of Cling-Surface and says, among other things: "We are perfectly satisfied with what it (Cling-Surface) has done and our intention is, when we put on another rope, to give it a thorough application of your Cling-Surface before the rope is put on."

THE HARTFORD BLOWER COMPANY, 120 Suffield Street, Hartford, Conn., have gone to press with a new catalogue, No. 56, entitled "The Hartford Blowers and Exhaust Fans," which illustrates and describes the well-known Hartford patent improved adjustable blowers and exhaust fans, steel plate steam and pulley fans, disk fans, countershafts, blast gates, dust collectors, etc. The Hartford Company make a specialty of installing heating, ventilating, and mechanical draft apparatus, and announce that they will be pleased to send one of these new catalogues, free of charge, to any one interested.

THE NATIONAL TWIST DRILL AND TOOL COMPANY, Detroit, Mich., announce the completion of their factory for the manufacture of reamers, cutters and all kinds of special tools. This has been equipped with modern machinery and an improved tempering process. They state that only high-class workmen are employed, and the most careful selection of steel made, with the object of placing on the market a product of superior quality. All their tools will be subjected to careful inspection and micrometer test. Mr. P. J. Hoenschied, their manager and superintendent, has had 22 years' experience in this line.

THE WILMARTH & MORMAN COMPANY, Grand Rapids, Mich., announce among their shipments of the "New Yankee" drill grinders in November, the following: Geometric Drill Company, New Haven, Conn.; English Iron Works Company, Kansas City, Mo.; Bridgeport Machine and Motor Company, Bridgeport, Conn.; Hydro-Carbon Light Company, Wichita, Kan.; Ideal Manufacturing Company, New Haven, Conn.; Fairfield Motor Company, Bridgeport, Conn.; Omega Steel Company, New Haven, Conn.; Homer D. Bronson Company, Beacon Falls, Conn.; North Penn Iron Company, Philadelphia, Pa.; Dodge Bros., Detroit, Mich.; Springfield Boiler and Manufacturing Company, Springfield, Ill.; New Jersey Zinc Company, Hazard, Pa.; Manning, Maxwell & Moore, New York; also seven drill grinders to England, and one to South America.

THE DETROIT LUBRICATOR COMPANY, Detroit, Mich., inform us that the Circuit Court for Wayne County, State of Michigan, issued an injunction on November 17 in their favor against the Michigan Lubricator Company, restraining them from using the words "Detroit Lubricators," "Improved Standard Lubricators," "Detroit Improved Standard Lubricators," in connection with their lubricators or advertising matter; also restraining them from using boxes or packages for their lubricators bearing the words "Detroit" or "Detroit, Mich.," unless their firm name be also given. For some time past the Michigan Lubricator Company have been making lubricators resembling those made by the Detroit Lubricator Company in outward appearance, and they have stamped on these lubricators and on the boxes containing them only the words, "Detroit, Mich.," making no mention of their firm name, the object evidently being to have such lubricators substituted for the genuine Detroit lubricators. In order to prevent their customers from being deceived and imposed upon by such tactics the Detroit Lubricator Company asked for this injunction, which was at once granted.